

A QUARTERLY JOURNAL OF METHODS AND INFORMATION FOR TEACHERS OF SCIENCE

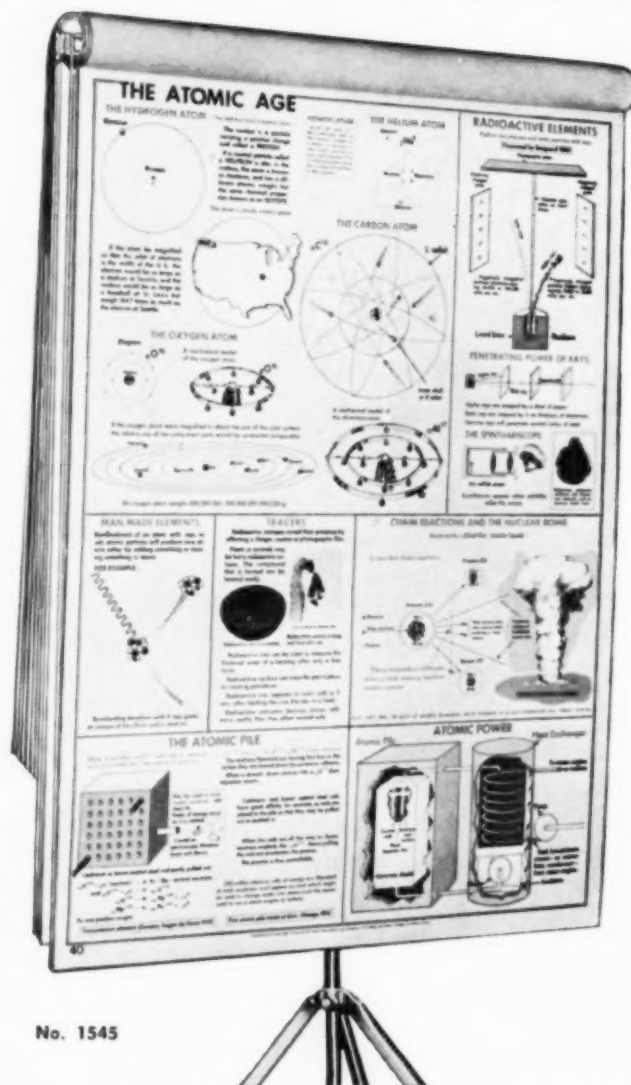
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# ***The* SCIENCE COUNSELOR**

**Volume XXI \* Number 3 \* Sept. 1958**

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# The Science Counselor

"FOR BETTER SCIENCE TEACHING"

A QUARTERLY JOURNAL of teaching methods and scientific information especially for teachers of science in Catholic schools. Indexed in the Catholic Periodical Index. Published at Duquesne University, Pittsburgh, Pennsylvania, in March, June, September and December by

DUQUESNE UNIVERSITY

Subscription Price: \$2.00 per year; Canada, \$2.25. Single copies of issues in the current year, 60¢ each.  
Business and Editorial Offices at Duquesne University, 901 Vickroy Street, Pittsburgh 19, Pa.

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### New Career Opportunities in the Challenging Field of Atomic Energy

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### Elementary School Arithmetic

By Sister Mary Angela Vogler, C. D. P., Elementary Schools, Diocese of Pittsburgh, Pittsburgh, Pennsylvania.

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By Sister Mary of the Angels, I. H. M., St. Rosalia's High School, Pittsburgh, Pennsylvania.

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### Automatic Analysis

By George L. Buc, Fisher Scientific Company, Pittsburgh, Pennsylvania.

### The New Importance of Bromine

By Albert E. Deline, Michigan Chemical Corporation, St. Louis, Michigan.

# Seeing Sounds

• By **Sister Helene Ven Horst, Ph.D.**, (State University of Iowa)

DEPARTMENT OF PHYSICAL SCIENCES, MARYCREST COLLEGE, DAVENPORT, IOWA

and **Helen Ven Horst**

*For centuries man's knowledge of sound has depended upon his sense of hearing. The oscilloscope has made sound "visible," and this visibility of sound makes possible a more accurate analysis of the nature of musical sounds.*

*Students of music and students of physics will find this article most informative.*

In our era of electronics it is not an overstatement to speak of "seeing sounds" and of "synthesizing music." Music is no longer considered purely an art—but an art enhanced by the beauty and orderliness of scientific principles. With the merging of the art of music and the science of sound, a whole new musical era is being entered upon, an era of transition wherein to know and appreciate music more completely it is necessary to have at least a basic understanding of the principles of sound.

The physics of sound dates back to the time of Pythagoras, who in the sixth century, B.C. studied vibrating strings experimentally. However, treatises on the direct correlation of sound and music<sup>1</sup> appeared not many decades ago. It would follow then that many of our masterpieces of music were written independently of a thorough knowledge of the physical science of sound. Here as in many other instances the art was highly developed before the science was born. The composer did not need to know the mathematical laws of science to write his music. As a result of years of training in correct and incorrect musical forms he could conceive in his mind the theme and the variations of his musical composition. Hundreds of years later the scientists ventured into this region of the arts and asked "why?" Why are some sounds pleasant and others unpleasant? Why does one sound differ from another? What makes sound? Can sounds be synthesized? Man's investigative mind is ever seeking newer ideas, so that with the advent of science there is linked the older method of hearing music to the more modern method of actually seeing musical sounds.

It is the purpose of this paper to develop the scientific phase of musical sounds from two points of view: (1) the actual synthesis of sound; and (2) the analysis of musical sound patterns.

Sound is adequately defined by Perkins<sup>2</sup> in this way: "Objective sound is a particular form of wave motion taking place in ponderable matter . . . due to an original vibration or disturbance set up in the sounding body." Sound may be further qualified by its effect on

the individual. If it is to be enjoyed, it should be pleasing to the ear; and it is this aspect that makes music relaxing and entertaining. On the other hand, noise, by the mere connotation of the word distinguishes it from harmony.

To better understand the nature of sound it is well to recall that sounds differ fundamentally in three ways. Perkins<sup>3</sup> distinguishes these qualities in this way:

(Sounds) differ in intensity (and consequently in loudness), in pitch, and in timbre, or "tone color." Intensity depends upon the energy contained in unit volume of the medium at any instant and is defined as the time rate of flow of energy across a square centimeter at right angles to the direction of propagation. In the case of a plane wave, this is equal to the energy density times the velocity of the sound. Pitch depends upon the frequency of vibration of the sounding body, that is, on the number of vibrations it executes per second. And timbre, in a complex tone like that of the violin, depends upon the resultant wave due to a combination of frequencies.

The rapid vibratory motion of the sounding object produces a longitudinal wave which is transmitted through some medium. Usually this medium is air; however, sound is also effectively transmitted through liquids and solids. The sound resulting from these vibrations may be analyzed from a study of the sound pattern produced. For example, in Fig. 1, curve A, there is the sound pattern produced when a pure tone is sounded. By a pure tone is meant a source of vibration

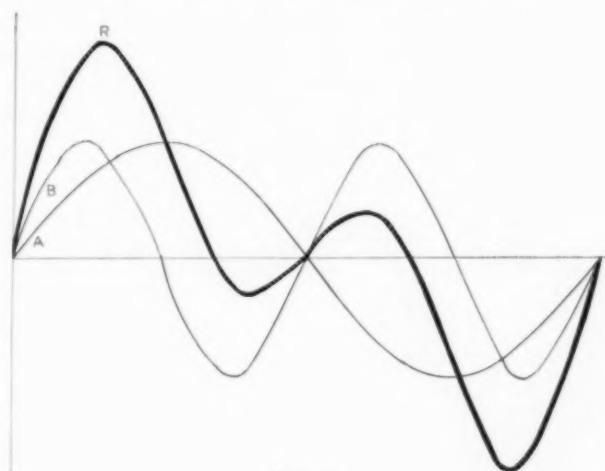


FIG. 1

- CURVE A — Wave pattern for a pure tone—one complete wave length.
- CURVE B — Wave pattern for a pure tone one octave above that of curve A. (Frequency ratio 2:1)
- CURVE R — Resultant wave pattern of fundamental frequency and first overtone.

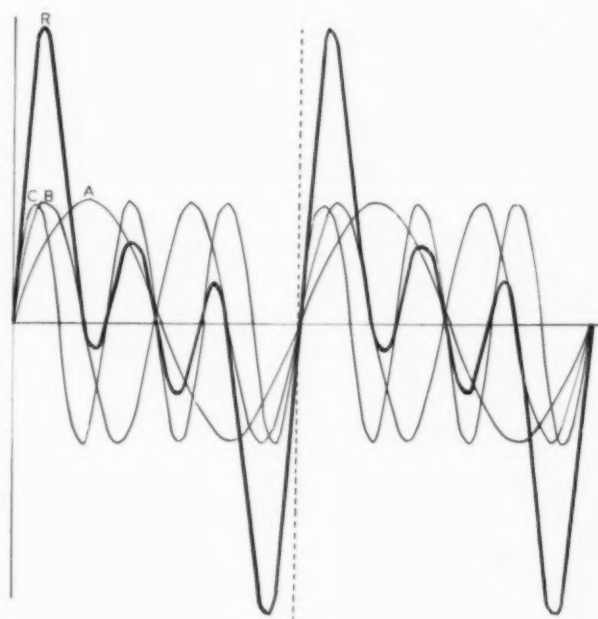


FIG. 2

- CURVE A—Fundamental frequency (ex.  $C_1$ ).  
 CURVE B—First overtone (ex.  $C_2$ ).  
 CURVE C—Second overtone (ex.  $C_3$ ).  
 CURVE R—Resultant wave pattern formed by the combination of curves A, B, and C. Notice the resultant pattern repeats itself for the second wave length of the fundamental (to the right of the dotted line).

which gives only the fundamental frequency with no overtones. This is difficult to produce and somewhat unpleasant in its sound. The simple tuning fork creates a sound wave which is closest to that of a pure tone. However, even in such cases there are overtones or harmonics produced. It is noted that in curve A of this figure there is one single vibration or tone pattern. This is recognized as a sine wave and is calculated by using the relationship

$$y = \sin x$$

By varying  $x$  between 0 and  $2\pi$ , the curve shown in the figure results. Curve B of Fig. 1 illustrates the sound pattern for a frequency twice that of the fundamental. This represents the first overtone or the second harmonic. It is produced by the object (air column, reed, or string) vibrating twice as fast as the fundamental, or in two segments. This additional vibration is very common among musical instruments. Bartholomew<sup>4</sup> states that of the first fifteen overtones of any series, the octave (1:2 relation) occurs eight times. This is a much greater frequency than any of the other overtones.

The effect of combining the first overtone with the fundamental is shown in curve R of Fig. 1. This sound pattern is noticeably different from either that of the fundamental or the first overtone. In arriving at the sound pattern produced by these overtones it was necessary to draw each sound pattern independently and

then add the two together algebraically. For example, when both sound waves extend upwards, the resulting wave is the sum of the two wave patterns. When the sound waves are in opposite direction, the resulting wave is the difference of the two waves.

But most instruments do not produce such simple tone patterns as these. The fact that it is possible to distinguish one musical instrument from another, or one voice from another, even though both are sounding the same pitch is due to the complexity of the wave patterns produced. Since the fundamental in all cases may be the same, the difference in sound is due to the intensity, the number, and the kind of overtones produced. This quality of sound is referred to as the timbre or tone color.

In 1862 Helmholtz published a volume<sup>5</sup> entitled *Die Lehre von den Tonempfindungen* (translated by A. J. Ellis, *Sensations of Tone*) in which is embodied the result of eight years of research in the field of the theory of musical sounds. He summarizes his findings in these words, "We are able to lay down the important law that difference in musical quality of tone depends solely on the presence and strength of partial tones, and in no respect on the differences in phase under which these partial tones enter into composition." Some investigators<sup>6</sup> notably, W. L. Barrows of M.I.T., disagree with Helmholtz and maintain that "a variation of phase not only makes striking differences in the multi-tone wave form as seen on the oscillograph but that it also produces marked differences in the character of the sound."

To understand the production of overtones it is best to consider the sound produced as a result of a vibrating string. The string may vibrate in one segment to produce the fundamental frequency. It is also very probable that the string will vibrate in two segments producing the first overtone, or in three segments producing the second overtone, or in sixteen segments producing the fifteenth overtone. Culver<sup>7</sup> lists the order of

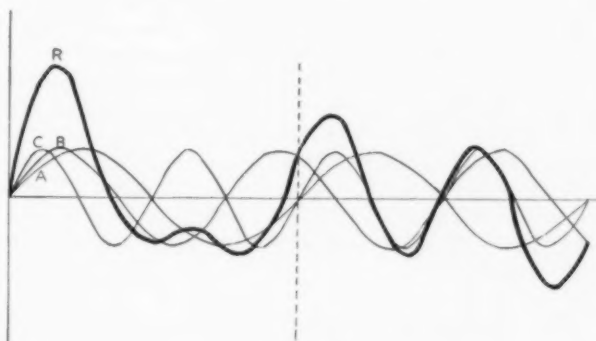


FIG. 3

- CURVE A—Fundamental frequency (ex.  $C_1$ ).  
 CURVE B—Wave pattern for a tone having an interval a fourth above the fundamental frequency (ex.  $F_1$ ).  
 CURVE C—First overtone (ex.  $C_2$ ).  
 CURVE R—Resultant wave pattern. Notice the unsymmetrical pattern of the resultant wave which is not repeated for the second wave length of the fundamental.

the first fifteen overtones for  $C_1$  as follows: (The sub-numbers indicate the respective octaves).

$C_1, C_2, G_2, C_3, E_3, G_3, B^b_3, C_4,$   
 $D_4, E_4, F^{\sharp}_4, G_4, A_4, B^b_4, B_4, C_5$

It is seen that in these fifteen overtones the octave of the fundamental appears four times. Octaves of other overtones appear no oftener than twice.

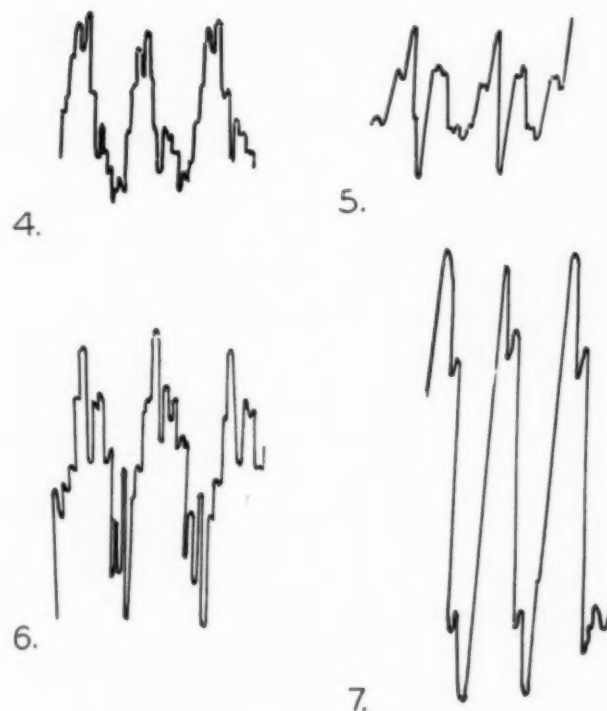
In an attempt to see the type of sound pattern that would result from several overtones, the sound pattern shown in Fig. 2 was constructed. Here there is indicated the frequencies  $C_1, C_2, G_2$ , that is, the fundamental and the first and second overtones. The resultant wave, curve R, was constructed by adding algebraically the component waves. It is to be noted that the resultant wave pattern, heavy line, repeats itself exactly for the second wave length of the fundamental frequency. This is shown to the right of the dotted line.

In Fig. 3 there is shown a wave pattern which can be produced on paper but which is impossible to produce on a musical instrument. It is evident that the resultant wave is very unsymmetrical and is not repeated regularly. This represents a combination of the fundamental frequency, and two overtones, one of which is non-existent in reality. In Culver's listing of the overtones this would be represented by the tones  $C_1, F_1$ , and  $C_2$ . Obviously, this combination does not occur.

The problem of synthesizing a sound pattern as produced by musical instruments is not an easy one. This is due primarily to the difficulty of knowing which overtones are present and which are absent and the intensity of these overtones. Then, too, there is no limit to the number of overtones which may occur. But unless there is some concrete evidence of what the synthesized sound should ultimately look like or sound like, the whole process is merely one of trial and error. This necessitates not only hearing the sounds but actually seeing them.

In the ordinary tape recorder, radio, or television set, sound waves are converted into electric impulses which vary in amplitude, frequency, and complexity. These electric impulses are then reconverted into sound waves by magnetic impulses which vibrate the speaker. In this experiment an oscilloscope was connected to the wires leading to the speaker of the tape recorder. In this way the electric impulses were fed into the oscilloscope at the same time they were vibrating the speaker. The oscillograms were photographed by means of a Speed Graphic timed for 1/25th second, using Royal Pan films.

Fig. 4 is the wave form or pattern for the violin. It should be noticed that the wave is considerably complex which would be expected since it is rather easy for a string to vibrate in many segments in addition to the fundamental. It is known that the violin and flute have only six overtones as compared with twelve for the oboe, twenty for the clarinet, and thirty for the horn. Although the pitch recorded for this pattern is for a frequency of 246.9 v/s, the picture was taken at half the speed. This produced a much more exact

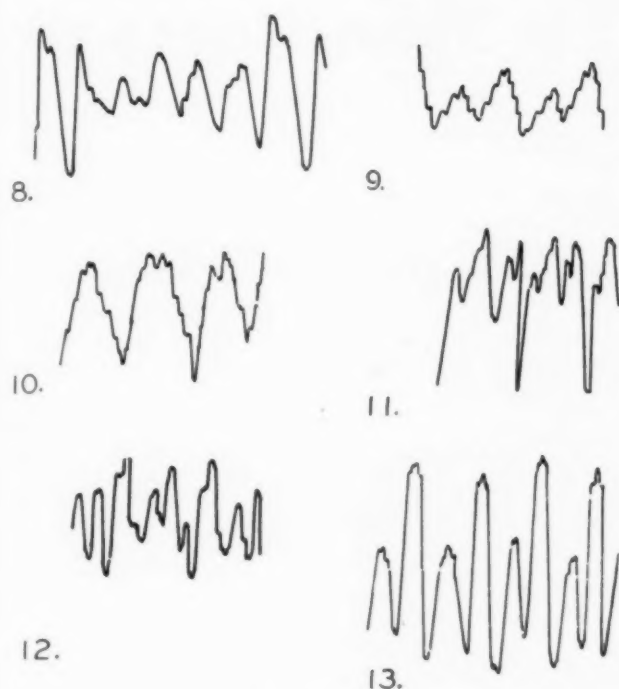


FIGS. 4 to 7

- No. 4—Wave pattern for violin, B below middle C, 246.9 v/s. Actual frequency shown is 123.5 v/s.  
 No. 5—Wave pattern for trumpet,  $B^b$  below middle C, 233.1 v/s. Actual frequency shown is 116.5 v/s.  
 No. 6—Wave pattern for clarinet,  $B^b$  below middle C, 233.1 v/s. Actual frequency shown is 116.5 v/s.  
 No. 7—Wave pattern for electronic organ, middle C, 261.6 v/s. Actual frequency shown is 130.8 v/s.

pattern. This procedure was followed for all photographs of the sound patterns. Fig. 5 is the sound pattern for the trumpet. According to Culver<sup>7</sup> the fundamental and first overtone of this instrument have full intensity, while the third and fourth are somewhat diminished. The intensity decreases consistently through the ninth overtone. As for other wind instruments, Culver<sup>8</sup> reports the intensity of the overtones. For the clarinet at a frequency of 180 v/s, the first overtone is entirely missing; the 3rd, 5th, and 7th are quite pronounced, while the 4th, 6th, 8th, 9th, and 10th are very low. The photograph of the clarinet sound in this study is shown in Fig. 6. The organ used in producing the tone pattern in Fig. 7 was an electronic organ. The plainness of this pattern is striking. In this regard Bartholomew<sup>9</sup> states, "In the pipe organ, whose tones on the whole are deficient in upper partials, 'mixed stops' are used, which for every key depressed will cause several pipes to sound, tuned to certain of the harmonic partials of the tone."

Lineback<sup>10</sup> analyzes the quality of tone by stating that "the fundamental tone alone would make rather dull listening. A predominance of high harmonics adds an effect of crispness, while the lower frequency components give power and dignity to music. Too much



FIGS. 8 to 13

- No. 8 — Wave pattern for bass voice, E<sup>b</sup> two octaves below middle C, 77.8 v/s. Actual frequency shown is 38.9 v/s.  
 No. 9 — Alto voice, A<sup>b</sup> below middle C. Vowel 'e' as in 'eh'. 207.7 v/s. Actual frequency shown is 103.8 v/s.  
 No. 10 — Same as No. 9 except vowel 'a' as in 'fate.'  
 No. 11 — Same as No. 9 except vowel 'a' as in 'ah.'  
 No. 12 — Same as No. 9 except vowel 'o' as in 'oh.'  
 No. 13 — Same as No. 9 except vowel 'u' as in 'noon.'

emphasis on the low harmonics may impart a muffled quality and an absence of frequencies between the lower and upper harmonics contributes a weird and hollow effect."

Piano tones were recorded but are not included in this study. The main reason for their omission is because these sounds, characteristic of all percussion instruments, are transient and change markedly from their original make-up after a very brief interval. On the oscilloscope the pattern of the piano sound was very nearly that of a pure sine wave shortly after the initial sound was made.

When the voice is considered as an instrument of sound, the same complex phenomena occur as with instruments. But in addition, the voice is capable of producing an entirely different wave pattern for each syllable that is spoken or sung. The individuality of the human voice is easily recognized. This is true because of the overtones. The wave pattern shown in Fig. 8 is a bass voice of 77.8 v/s. The actual pattern represents one octave below the recorded frequency. The complexity of overtones is again evident. It is quite obvious here that the lower the pitch the greater possibility there is of an increased number of overtones.

With the alto voice, shown in Figs. 9 to 13 the pattern is much simpler, due primarily to the higher pitch. The distinct pattern shown for each of the vowels is proof of the remarkable ability of the human voice to produce an entirely different set of overtones for each vowel enunciated. Sound waves of human voices really have a personality about them. Each is distinct and different from another. Each has its own peculiar choice of tone color.

What effect will the invasion of science have on the art of music? To answer this question two modern writers are quoted. Norman Pickering<sup>11</sup> interprets the application of science to music in this way:

... We may rule out new instruments and speculate only on electronics for say, Beethoven. The obvious basis for a tone generator is the magnetic tape recorder. The basic ingredients of the performance could be stored on tape loops, which would be analogous to the little vials on the druggists' shelves. It would be the essence of the job to mix the prescription properly (the prescription being the composer's score). Obviously, in such a system some individual would still have to direct the performance, so that the human element would still exist in the interpretation. The conceivable perfection of execution would probably satisfy even the fussiest of today's conductors until he discovered that *he* was the only limitation on the musical performance. Such a ghastly realization would send the strongest man scuttling back to the shelter of the old-fashioned orchestra with all its imperfections.

Stuckenschmidt<sup>12</sup> sees no limits to the vastness of the future horizons in music.

In synthetic music . . . unlimited is the range of tone colors. In this department infinite gradation is also possible so that the tonal spectrum may be likened to the color spectrum in the realm of optics. Mechanical limitations of speed have also been eliminated, and dynamically speaking anything can be instantly produced from the faintest pianissimo to the most thunderous fortissimo. Music thus leaves the human sphere, with its thousand physical limitations and enters the fantastic realm of technical omnipotence. Olivier Messiaen, who is both practically and theoretically experienced in utopian worlds of sound, has summed up the situation with the words: Music has now reached the peak of its possibilities.

While such gateways of music may lie beyond the hopes of the conservative musician, it would seem, nevertheless, that the beauty of this art would be enhanced by a better understanding of its scientific principles. ●

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5. Culver, p. 60.
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# Optical Glass And Its Manufacture

• By Neill M. Brandt

MELLON INSTITUTE, PITTSBURGH, PA.

*This and the following article are from radio talks sponsored by the Pittsburgh Section of the American Chemical Society.*

*The talks for the 1952-1953 season were digested and printed in a booklet, "Chemistry and You." These articles are reprinted with the permission of the Pittsburgh Section.*

Nearly everyone knows Pittsburgh as the center of the steel industry; relatively few realize that Pittsburgh is also the center of the ceramic industry. However, a substantial part of America's brick, tile, sanitary ware, pottery, and glass products are manufactured in the Pittsburgh area.

Pittsburgh is also the location of Allegheny Observatory, known for its studies of the light from many of the important stars and for its part in the development of our system of standard time zones. These contributions were made possible by the Observatory's excellent instruments. The optical elements of these instruments are made from fine optical glass—crystal clear glass made with infinite care from the finest raw materials available.

All glasses are basically the same in that they represent a peculiar state of matter, neither true solid nor true liquid. They cannot be classified as true crystalline solids, because their internal structure lacks regular lattice array. The internal structure of glasses appears to be one of a random, three-dimensional network of atoms or ions. In addition, glasses have no sharply defined melting point but slowly soften as the temperature is raised; they do, however, have solid-like rigidity at ordinary temperatures. Only at elevated temperatures do glasses possess sufficient fluidity to conform to the shape of a container. Precise measurements made on the 200-inch disc at Palomar indicate that there is no appreciable flow of glass at ordinary temperatures. Some glass technologists have met this dilemma by postulating a fourth state of matter—the vitreous or glass state.

Glasses may be classified into several general families with respect to their chemical composition. Some of these groups are: soda-lime glass, such as most bottle glass, window glass, plate glass and ordinary crown optical glass; the borosilicates, including pyrex and borosilicate optical glass; fine crystal table ware and flint optical glasses are examples of flint glasses. Optical glass families include crowns, borosilicates, barium crowns, barium flints and crown flints. While almost all glasses contain silica as a major constituent, the barium family contains barium oxide and the boro-

silicates, boron oxide as secondary network formers. Flint glass received its name originally from the use of flint as a source of pure silica; however, that use of the term has become obsolete, and now "flint" generally signifies the presence of lead.

Optical glasses have been listed among the examples for each of the general classifications mentioned to imply that chemical composition is not the feature which distinguishes optical glass from common glass. Almost any piece of common glass could function as optical glass, if it were uniform enough in its physical and chemical properties and were free from impurities that would cause undesirable color. Iron in excess of 0.03% in glass sand produces too deep a green color for optical glass.

The major function of optical glass is to bend, or refract, light rays. Quantitatively, this property is measured as index of refraction. The property known as dispersion signifies the differences in refraction for different colors; it is the effect that produces a rainbow when sunlight passes through drops of water. Quantitatively, dispersion is a number obtained by certain simple mathematical operations involving the refraction at each end and at the middle of the visible spectrum.

These two physical constants, refraction and dispersion, along with focal length, field to be covered and various other specific limitations, supply the data required for designing a lens system. The design process requires lengthy calculations, to obtain a correct match of the various radii of curvature of the lens components; and the computation is usually complicated by the fact that a number of different types of glass may be used.

These correct curvatures are usually produced in several stages. First, a lump of glass is heated and pressed to approximate shape and size. After this pressing operation the glass must be annealed. In the broadest sense, annealing of optical glass is a process of heat treatment, to control strain; while the control of uniformity of refractive index and other physical properties of glass is generally known as stabilization. Recently, stabilization processes have been given precedence over strain-control processes. After annealing, the glass is ground to nearly correct dimension with some grinding compound—usually emery. Finally the polishing operation is used, to make the ground surface transparent and to bring the contour of the surface to its final form. The required precision of the surface is attained by a polish-and-measure repetition, until the theoretical curvature has been approached to the limits of the tools and test equipment. The "yardstick" in these measurements is a fraction of a wave-

length of light. Measurements to within a few millionths of an inch are easily attained.

There are many problems throughout the whole optical industry. For each one that is solved, many more are provoked. Nevertheless, each solution invariably leads to better optical equipment and, usually, to a reduction of cost. ●

## Iron And Steel

By L. M. FOSTER AND R. D. WILLIAMS  
ALUMINUM COMPANY OF AMERICA

The terms "iron" and "steel" are frequently used interchangeably. To the chemist, however, there is a distinct difference. Iron is a pure chemical element and as such is seldom encountered outside the laboratory. It is very ductile, has only moderate strength, is very susceptible to corrosive attack by many chemical agents and in general has limited usefulness. Steel is an alloy whose major constituent is iron. The alloying additions may comprise a large part of the alloy—for example, the stainless steels—or may be present only in trace amounts. In either case, gross changes in the physical and chemical behavior of the metal can result.

The development of civilization is closely connected with the use of iron; the more extensively a race made use of iron in its many forms, the greater became its importance. The remains of prehistoric races show acquaintance with iron whose origin was probably metallic meteorites. It is impossible to give the date of the earliest use of iron since iron, unlike copper, bronze and gold, will not withstand the ravages of atmospheric corrosion, and rusts away. It is known however, that iron was used as early as 4000 years B.C. in Asia and Africa, and perhaps had its industrial origin there.

Iron is one of the most abundant metallic elements. However, the only economical sources of iron today are the many iron ores, which with few exceptions are iron oxides. The most important of these are the oxides, hematite and magnetite, and the hydrated oxide, limonite.

The principal ore deposits in America are classified generally as Lake Superior, Alabama, Appalachian and Western States. The Lake Superior region supplies 85% of the ores melted in the United States, and the present-day iron and steel industry in North America is based on ores from this region. The recently reopened Southern Utah deposits furnish the bulk of the ores used in the Western States.

Iron is reduced from its ores by heating them to a high temperature in the presence of carbon. By far the most important process for this is the blast furnace process. The external appearance of a blast furnace is well known to most residents of Western Pennsylvania. Possibly only a few, however, know what goes on inside a furnace.

An iron smelting plant consists of two main parts, the blast furnace itself, and a heat exchange device

called a stove. Then, of course, there is auxiliary equipment for transporting materials, collecting dust, storage and many other operations. The heart of the plant is the blast furnace itself. Here the raw iron ore is reduced to metallic pig iron. The stove, as the name implies, is a heater for heating the air that leads into the furnace. The blast furnace proper is a cylindrical chamber 100 or more feet high and about 20 feet in diameter at the widest part. At the top is a means of introducing the charge and taking off gases. At the bottom is a tap hole to take out the iron, and another hole a little higher to take off molten slag. Around the belly are a number of ports or tuyeres to introduce preheated air from combustion.

The process by which iron oxide is converted to iron metal is one of reduction. At the high temperature of the blast furnace, carbon, in the form of coke, combines chemically with the oxygen of the iron oxides to form carbon monoxide gas and leaves the iron in a metallic state. This is a very simple description of a very complex process. Iron ore contains many things besides iron oxide. There are silica and aluminum oxide from clay, phosphates, sulfides and dozens of other impurities in small amounts. Most of these substances must be removed if the product is to be useful. This purification is accomplished to a large part by the addition of crushed limestone which acts as a flux. The limestone melts under the intense heat of the furnace and most of the impurities dissolve in it. This molten material, which is called the slag, is lighter than the molten iron and floats on top of the iron pool and is tapped off separately.

The pig iron that is tapped from the blast furnace is useless in that state. It is hard and brittle because it contains several percent of carbon that dissolves in it in the furnace. This carbon can be removed in several ways. In the old wrought iron process, the pig iron was remelted in a furnace lined with crushed ore. The carbon in the iron reacted with this lining to form small amounts of slag. While the melt cooled, it was continually stirred so that traces of slag were intermittently mixed in. This entrapped slag made the final product resistant to corrosion, the outstanding characteristic of this early product.

Today, the properties of corrosion resistance, high strength and workability are achieved by appropriate additions of alloying agents to form steel. The carbon of the pig iron is burned out with an air blast in the Bessemer converter or some similar equipment; then small quantities of other elements are added to give the desired properties. For example, stainless steel usually contains considerable chromium and nickel; tool steels frequently contain carbon, vanadium, molybdenum, tungsten, cobalt and other elements.

The number of different steels made is tremendous but this is not surprising when one realizes the countless different products made from these alloys. Pittsburgh has been a major center of development of these products; she can be proud of the prominent position she still retains in the iron and steel industry. ●

# The Impact of Modern Mathematics On the Catholic High School

• By Sister M. Stephanie, R.S.M., Ph.D., (The Catholic University of America)

GEORGIAN COURT COLLEGE, LAKEWOOD, NEW JERSEY

*This very timely article should be carefully read by every mathematics teacher and school administrator.*

*Very few critics of the secondary teaching of mathematics realize the tremendous changes taking place in the teaching of mathematics.*

Many mathematics teachers have probably been asked sometime during the past year by one of their non-mathematical colleagues, "Just what is all this I hear about modern mathematics?" Perhaps the principal asked the question. In most cases the mathematics teacher in a Catholic high school knows the answer, but does not know just how a change in the mathematics curriculum is going to affect him. Should he try to add material to the present prescribed course of study? Should he try to bring about a change in the course of study? What are other schools doing?

At teachers' meetings all over the country, at national conventions, at the meetings of state groups, and in small faculty sections within a school, there has recently been much discussion on the need for some change in the mathematics curriculum. Trends in education are like other trends—they follow each other in cycles, and fashions in mathematics teaching are no exception. If one reads *The Mathematics Teacher*, for example, of ten years ago, he sees many articles, in fact almost entire issues, devoted to the problems of "the other eighty-five per cent," those students who will not go to college. In 1948 there was talk of general mathematics and consumer mathematics and social mathematics, usually all names for a continued (or repeated) arithmetic. It was argued that what was needed was practical computation, the arithmetic of daily life, and that algebra and geometry were for the few. Now the journals hardly ever mention such courses, although many schools still offer them and frequently with good reason, for in 1958 there remain students who can profit from such courses. The journals for the spring and fall of 1958, however, are full of articles on set theory, and Venn diagrams and symbolic logic, and probability and statistics for high schools, with no mention at all of general mathematics, and only faint whispers about geometry and trigonometry.

What does this new trend mean for the teacher in a Catholic high school? It is not a fashion, not something that will "blow over" in a year or so, it is not the idea of just one person who has a particular axe to grind. The change in the mathematics curriculum (or, rather,

changes, for several have been proposed) is something good, something desirable, and something that must be investigated closely by every teacher in a Catholic high school, whether that teacher be priest or brother, sister or lay person, experienced or the newest of beginners. Change is not good just because it is change, movement for the sake of movement, but it is good if it brings about improvement and every realistic mathematics teacher will admit there is room for improvement in the present day mathematics instruction. All the new programs are based on the premise that mathematics is not a collection of tricks and arbitrary manipulations to be learned in isolation and summarily forgotten, but rather a series of emerging patterns which the student must be taught to see, so that he will perceive the regularity of mathematics and the relationships existing among its many parts. Recognition of these relationships cannot begin too early.

Educators are not yet completely sure of what form the new curriculum will take, and all programs are still in an experimental stage. There will probably never be a time when all administrators and teachers agree unanimously that a certain program is without peer and should be adopted throughout the country. Currently there are at least three new plans. An article in a recent *Scientific American* gives a good resumé of these.<sup>1</sup>

One group at work on curriculum revision is the Commission on Mathematics of the College Entrance Examination Board, set up in 1955. This Commission has published numerous pamphlets on its objectives, and on practical ways of attaining these objectives in classroom practice. These pamphlets are obtainable from the Commission office.<sup>2</sup> The Commission proposes to make no great changes in the algebra course content, but to give greater emphasis to inequalities than they receive now, to make much use of the theory of sets, and to show the pupil that algebra, equally with geometry, is a deductive science, based on only a few principles. In geometry the Commission wishes to reduce the number of required proofs, introduce analytic geometry immediately after the Pythagorean theorem and thereafter use analytic instead of synthetic proofs if they are more direct, and introduce solid geometry as part of this course and not as a separate subject. There is less emphasis on numerical trigonometry, more on analytic. Various patterns are suggested for twelfth year mathematics, one of them being a course in probability and statistical inference. For this last course, the Commission has written a textbook.<sup>3</sup> There are no textbooks for the other courses, although the Commission hopes that some will soon

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# An Ancient Metal - Lead

• By **James A. McCulloch, Ph.D.**, (University of Pittsburgh)

ASSOCIATE PROFESSOR OF CLASSICS, DUQUESNE UNIVERSITY, PITTSBURGH 19, PENNSYLVANIA

*The Carthaginians thy merchants supplied thy  
fairs with a multitude of all kinds of riches, with  
silver, iron, tin and lead.* —Ezekiel 27, 12.

Lead, one of the most commonly used metals in the twentieth century, is one of the oldest elements known to man. In addition to many of its modern applications which can easily be traced back to antiquity, intensive research programs have developed many new lead products which have become commercially important in this atomic era. Lead has played, and without doubt will continue to play, a vital role in the history of civilization. Because of its low melting point (619 F.), softness and malleability, lead was a very popular metal in the ancient world. The easy working properties of this serviceable element made it possible for the ancients to utilize lead in the absence of metallurgical knowledge for working other known metals.

Down through the centuries the uses of lead were many and varied. The plan of nature was such that all ancient civilizations had access to this wonderful mineral. Knowing no continental boundaries,<sup>1</sup> lead was mined from very early times in both the Eastern and Western hemispheres. While the scope of its uses in antiquity can not be fully covered, a resumé provides a few interesting examples of the practical utilization of the element, and even some foibles associated with its supposed antidotal effects.

Some 4,000 years ago the people of China used lead as a medium of exchange. However, when the government changed from a lead to a silver monetary standard, the mining of lead was forbidden by law in order to combat counterfeiting.<sup>2</sup> In Crete, where European civilization began, the people of the Late Minoan period employed lead for weights as did the inhabitants of the Late Bronze Age lake villages in Switzerland.<sup>3</sup> The cyclopean palaces of the Mycenaeans featured leaden water-tanks, and in ancient historic Greece the joints of coffered ceilings in temples were sometimes water-proofed with molten lead. In Rome a great amount of lead was consumed just as it is today in the form of compounds in pigments, paints, and cosmetics.<sup>4</sup> The principal compounds appear to have been lead carbonate, lead acetate, lead monoxide or litharge and red lead or minium. Other uses of the dull, heavy, pliant, greyish-blue metal included a wide range of items such

as: charms, ornamental objects, jewelry, loaded dice, clamps, dowels, theater tickets, armor, projectiles for warfare and medicines. An interesting sidelight to the pseudo medicinal worth of lead may be found in an item about Nero. The emperor is said to have worn a lead plate over his chest, when singing, to protect his vocal organs.<sup>5</sup>

The most important single application of lead in the history of antiquity was its use as a conductor of water in the pipe industry. Although the Egyptians and the Greeks manufactured lead pipes, it remained for the hydraulic engineers of the Roman Empire to employ lead on a large scale in their monumental public and private building programs. Aqueducts, cisterns, fountains and particularly Roman baths were serviced by a very elaborate system of lead pipe. As a matter of fact, lead was also used for structural purposes in the erection of public baths. Some were lined with sheet lead much in the same manner, although not for the same purpose, as X-ray rooms in modern hospitals. Even the private dwellings of the city of Rome commonly received their water supplies from distributory systems through pipes of lead. There was little or no danger of lead poisoning in Roman public water supplies. It seems that there was stable organic matter in the water which formed a protective coating in lead pipes, and thus prevented plumbo-solvency.<sup>6</sup> But, a few ancient architects, considering the possibility of plumbism, preferred earthenware pipes to deliver water for home consumption. Vitruvius in his *De Architectura* contends that "water is far more wholesome from earthenware pipes than from lead pipes because water seems to be made injurious by lead . . . Thus if what is produced from anything is harmful, there is no doubt that the thing itself is also harmful . . . Ergo, it seems that water should by no means be brought (via

ALMOST PERFECTLY PRESERVED LEAD PIPE used by the ancient Romans for conducting water. Latin inscription on middle pipe indicates it was manufactured during the reign of the Emperor Domitian (51-96 A.D.).

—Courtesy of Lead Industries Association





—Courtesy of Lead Industries Association

THE USE OF LEAD in the manufacture of storage batteries accounted for almost a third of all lead consumed in the United States in the past year.

lead pipe into the home), if we wish to have it wholesome."<sup>7</sup>

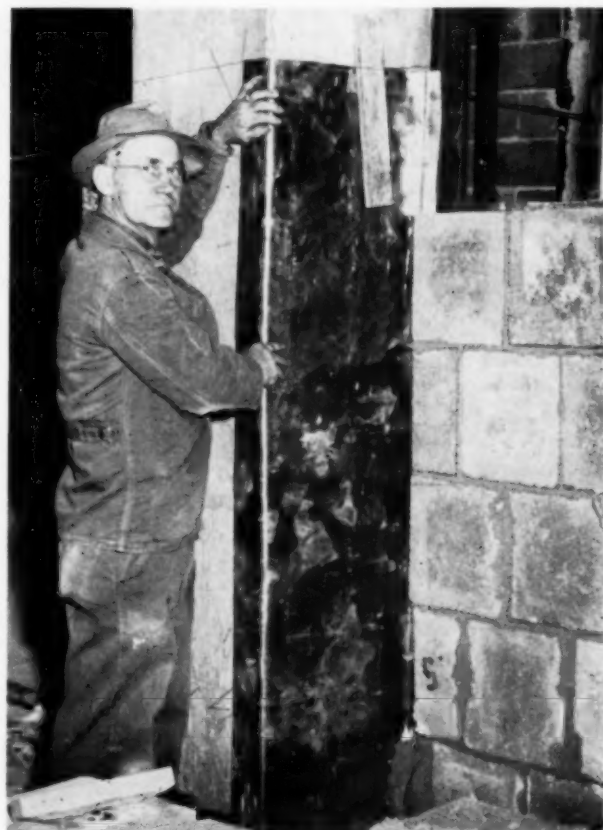
While earthenware pipe may have been preferred in direct lines to private homes, nevertheless, the use of lead was so widespread in water systems that the Latin word, *plumbum*, for lead came to mean a lead spout. It is from two consonants in the word *plumbum* the chemical symbol (Pb) for lead is derived; and it is from the same word that we get such rich and interesting English derivatives as: plumb, plumbago, plumbous, plumber, plumbery, plumbic, plumbiferous, plumbing, plumbism and plumbous.

The pipe industry in ancient Rome was a prosperous and thriving enterprise wherein was found the first successful attempt in the history of technology to develop and produce a logical series of standardized products.<sup>8</sup> Lead pipes were fabricated in 15 standard sizes and normally in lengths of not less than 10 feet.<sup>9</sup> The pipe's size, however, was not determined by its I.D. or O.D., but from the width of the leaden sheets before they were placed on a shaft or mandrel and soldered. Thus a pipe made from a plate of lead 40 inches wide would be called a 40 inch pipe.<sup>10</sup> After the sheets were fitted together and welded at the join-

ing with a lead-tin alloy,<sup>11</sup> the pipes took on a pear-shape rather than a round form.

Much information about Roman pipes and fittings is contained in the technical treatise *De Aquae Ductu* of Sextus Julius Frontinus, a Roman water commissioner from 97-103/4 A.D. It is from this man that we learn that while there were 25 standard ajutages, only 15 were in common use.<sup>12</sup> Although lead was used for pipe, the ajutages, which regulated the measurement of water, and all other fittings were made of bronze. Each ajutage had to conform to certain specifications<sup>13</sup> and had to be so stamped after a government inspection. Frontinus notes in his publication that "care must be taken, as often as an ajutage is stamped, also to stamp the adjoining pipe over the length prescribed by law. For then only can the overseer be held fully responsible, when he understands that none other than stamped pipes are to be set in place."<sup>14</sup>

Lead pipes were marked by means of wooden stamps on which raised letters were cut. These patterns were pressed into molds upon which lead sheets were cast thus producing a marking in raised letters. The information obtained from inscriptions found on lead pipe products has shed light upon the water system of Rome. Inscriptions vary in that the earliest, dating



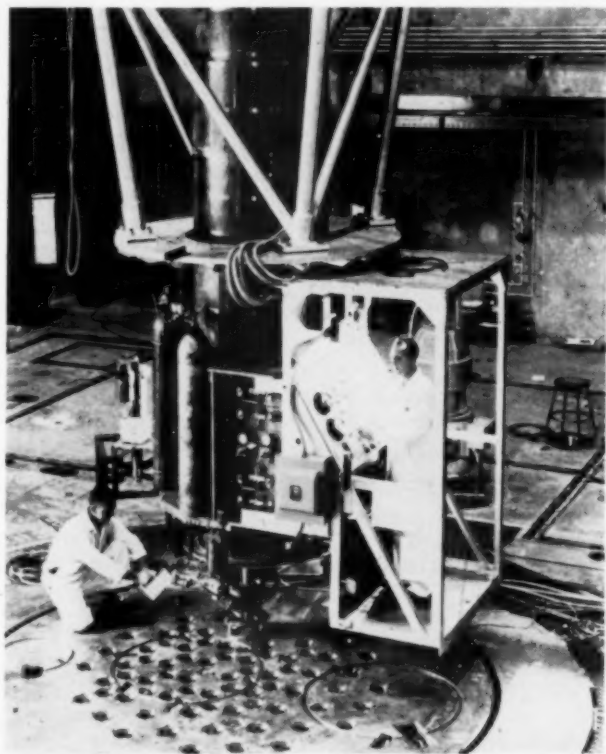
—Courtesy of Lead Industries Association

MEMORIAL HOSPITAL, Springfield, Illinois. X-ray room is lined with 6-pd. sheet lead. The columns are also lined with sheet lead, while the walls are made of cinder block lead sandwiches.

from the Age of Augustus, merely show the name of the emperor; whereas inscriptions of the second and third centuries usually contain the names of the emperor, water commissioner, and fabricator or slave who made the pipe. In particular cases the markings found upon pipe servicing private estates often give the proprietor's name, and in others the capacity of the pipe is indicated.

Epigraphic evidence is also of social importance since some markings, for example, reveal, among other things, that women were not confined to the home as they were in Greece. In fact, they apparently had, if we are to judge from inscriptions, a great deal of freedom in the world of business. Women owned and operated small plumbing shops and fabricating establishments,<sup>15</sup> with slaves to do the work. Pipes, however, whether fabricated by publicly owned slaves or by private contractors had to meet the specifications of the Roman Water Board.

It is significant that the Romans despite the need for huge quantities of lead pipe, especially when they had achieved standardization of product and parts, did not develop a factory system based upon quantity production. The small shop system remained the dominant feature of Roman commerce throughout the history of Rome. After the fall and decline of the Roman Empire there were few revolutionary changes in the basic uses of lead or its methods of fabrication until the eight-



—Courtesy of Lead Industries Association

A LEAD-SHIELDED CHAMBER for loading and unloading uranium fuel for a sodium reactor hovers over the "core" sunk beneath the ground.



—Courtesy of Lead Industries Association

A NIKE-CAJUN ROCKET as it begins its flight. Lead sulphide is used in missiles of this type for the continuous measurement of water vapor in the earth's atmosphere.

eenth century. The advent of the modern factory system in the nineteenth century was marked by rapid changes and technical improvements which renovated the processing of lead and expanded its application. Yet, the most important and phenomenal technological advances in the use of this lowly metal have been made within the twentieth century. With continual and increased emphasis upon chemical and metallurgical research, lead, an ancient dull mineral has taken its place alongside such romantic elements as strontium 90, technetium 99 and cerium 144.

As antiquity found a plentiful market for lead in the manufacture of pipe, similarly, the United States, the world's largest consumer of lead, uses considerable quantities of lead for piping installations in homes, hospitals, laboratories and factories. The greatest American economic demands, however, are to be found in the production of storage batteries, anti-knock compounds (tetraethyl-lead) in the petroleum industry, and sheathing for electric cable.<sup>16</sup> These three uses accounted for 58% of our total estimated lead production

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# Projects Build Young Scientists

• By Shirley Moore

SCIENCE SERVICE STAFF WRITER

*Thousands of young students already are preparing to join the ranks of the world's scientists. They are absorbing scientific methods, attitudes and enthusiasm through year-round work in their individual projects, stimulating reading material and personal contact with professional scientists. Each year greater numbers of young people are producing increasing advanced and skillful projects.*

*This article is from a Science Service Feature News-Feature Story.*

People who know very much about science fairs are not easily frightened by dour-faced prophets of democracy's scientific failure.

Anyone who has seen for himself what the younger generation is questioning and building and discovering cannot take these prophecies very seriously. Instead of dark pictures of second-rate doom, such people persist in seeing a vivid kaleidoscope of children and teenagers working away at engrossing scientific projects.

Thousands of young students are planning and developing projects right now, in the summertime. School is out, and there is no pressure or incentive except their own driving joy in exploring and their private plans to enter next year's science fairs, or the Science Talent Search for the Westinghouse Science Scholarships and Awards, or other scientific competitions.

This year nearly 470,000 students—87.5% more than last year—exhibited the results of their work in science fairs preliminary to regional fairs affiliated with the National Science Fair.

Young people of all ages have taken to science projects as naturally as to any other kind of adventuring. They search the libraries, newspapers, scientific magazines and professional journals for the latest reports of significant research and challenging questions they might try to answer. As a matter of fact, they are such eager sleuths that adult scientists are often startled to find some of the frontiers of modern science rather competently mapped by young exhibitors at science fairs!

At this year's National Science Fair in Flint, Mich., for example, visitors could study graphically presented investigations of the new theory of the anti-universe, an ionic drive reaction motor, electroluminescence, and a method of producing oxygen from algae during space flight.

There were projects on solar energy and heat, and a solar motor; and another on cryogenics. Spectro-

graphs, spectroscopes and spectrometers attracted the attention of visitors along with telescopes, a solar furnace, a cold chamber, an electron microscope and a polarographic analyzer.

Aerodynamics and weather study exhibits included a project on the upper air and one on seismology; an original sport plane; many on special problems of rockets, missiles and satellites; and even a model lunar colony.

Everything from stress, cancer and muscular dystrophy to the common cold and the action of tranquilizers was looked into by high school pre-medics. One student demonstrated tests of his theory of "Rhythm in the Id," in an attempt to show that rhythm can be learned during sleep.

The slide rule and electronics specialists had had a glorious time "automating" musical composition, tests of people's powers of logical analysis, typing and stenography, and the rapid solution of complex problems in propositional calculus.

Group and number theory, prime numbers, topology and many abstruse mathematical problems were taken apart and put together again by enthusiastic mathematicians. They seemed to have a special yen for tackling abstruse problems that are highly improbable for high school students; that is, by common educational standards.

There were also such ingenious items as a frictionless spring, plastics made from gelatin and a lightweight concrete. Studies were presented on the effect of temperature on the action of insecticides; the control of Dutch elm disease and of bollworm infestation; on detergents and on the corrosion of steel; to mention just a handful of the outstanding projects on display at the fair.

Where do all these items come from? What is it that stirs up a young person's curiosity and imagination to the point that he is not only willing but determined to spend his after-school hours, weekends and summer vacations tracking down the answers?

To tabulate an accurate reply to this important question, Science Service asked the 281 finalists at the 1958 National Science Fair where they found the ideas for their winning projects.

The largest number, 38%, said they discovered their basic "springboard" ideas in magazines, journals, newspapers and books. (One idea came from an advertisement and one from Science Talent Search literature.) Such reading was the source of almost twice as many inspirations as any other. This suggests immediate and relatively simple action that can be taken by parents, teachers, librarians and other people and or-

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## **Ion Exchange Resins In Science, Industry And The Home**

• By **H. E. Weaver, Ph.D.**, (Brown University)

SUPERVISOR OF ION EXCHANGE SALES AND DEVELOPMENT, ROHM & HAAS COMPANY, PHILADELPHIA, PA.

ION EXCHANGE is basically a method of effecting quantitative separations, and as such it has been found useful in chemistry, engineering, biology, medicine and in many other sciences.

The author outlines the history and theory of ION EXCHANGE RESINS and discusses their major uses.

### **What Is Ion Exchange?**

Ion exchange may be defined in simple terms as the trading of ions that occurs when certain compounds are permitted to inter-react. Although the ions in chemical compounds are bound together in definite ratios to form molecules, there is no electrical charge on the molecule as a whole. However, when the molecule becomes ionized in water, its charged components are free to wander throughout the water and perhaps to form molecules with other types of ions that may be present in the solution. If the ion carries a positive charge, it is known as a cation. If negatively charged, it is called an anion. An everyday example of ion exchange is the reaction in water of calcium sulfate or magnesium sulfate (compounds whose presence in water causes a scaly deposit in tea kettles or in boilers) with sodium carbonate or with sodium hydroxide. A "swap" of ions occurs and new compounds are produced.

Like any natural phenomenon, ion exchange is not new. It has existed as long as the Earth itself and is probably as old as the universe. Knowledge of the mechanism by which ion exchange proceeds, however, and the ability to make of the process a useful technique for science and industry is relatively new. It has been only within the past century that the nature of ion exchange reactions has been investigated. Less than half of that century has seen ion exchange actively applied.

### **Evolution of Ion Exchange Resins**

The first real information on ion exchange, as we know it today, derives from the work of J. Thomas Way, a consultant to the Royal Agricultural Society of London. From 1850 to 1854, he investigated what we now know to be the cation exchange characteristics of soils so thoroughly that it is doubtful if any work until 1935 equalled or surpassed his in importance.

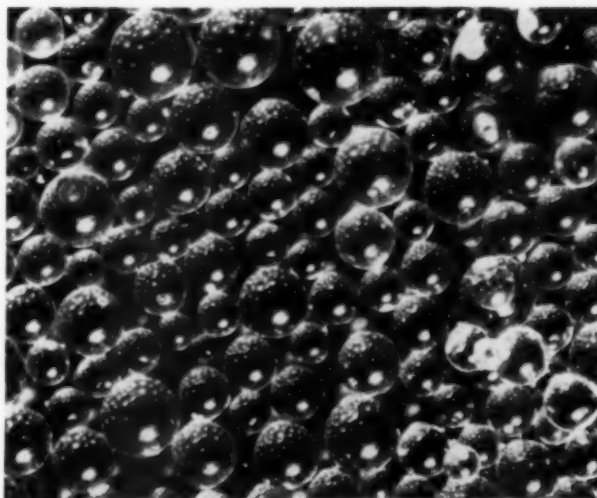
Some fifty years later, R. Gans applied ion exchange commercially when he adapted naturally-occurring greensands or "zeolites" (glauconites and bentonites) to the process of water softening. Subsequently, because of the limited capacity and durability of these

siliceous materials, attention was directed toward the production of somewhat higher capacity zeolites by chemical treatment of greensands. This work, in turn, led to the production of the so-called synthetic gel zeolites by reacting alkalis with aluminum salts. Gans utilized these, as well as natural exchangers, for softening water and for treatment of sugar solutions.

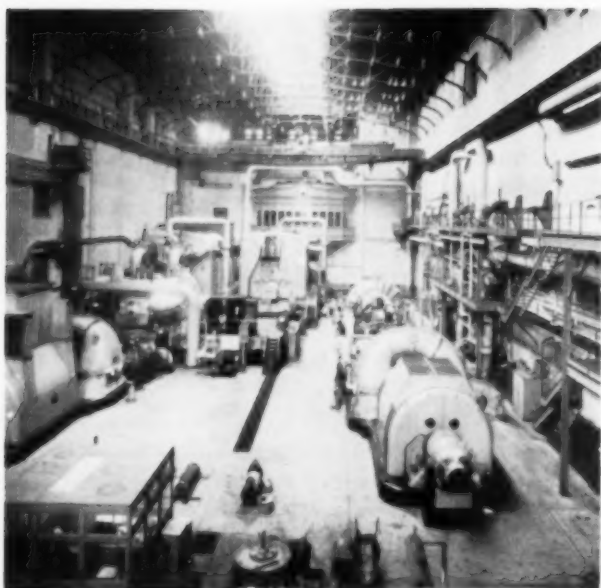
Ion exchange, thereafter, served its apprenticeship—from the turn of the century until 1935—almost entirely in water conditioning. Then B. A. Adams and E. L. Holmes, two British scientists in the Department of Scientific and Industrial Research, produced the first practical synthetic resinous exchanger. Their studies revealed that phenolic, sulfonic, and amino type resins could be synthesized which would permit the reversible exchange of cations and anions. The value of synthetic ion exchange resins was recognized by Rohm & Haas Company of Philadelphia, who secured licenses under the patents of Adams and Holmes and inaugurated a large-scale research and development program in ion exchange technology. This program, in 1940, brought forth the first commercial synthetic cation exchange resin in this country, forerunner of a host of anion and cation exchangers known as the Amberlite resins.

As anticipated, the new ion exchange resins found their initial use in water conditioning. Here, because of their efficiency, attrition resistance, high capacity, and superior chemical resistance, they quickly established new standards of industrial water quality.

The Amberlite ion exchange resins were destined



IN THIS PHOTOMICROGRAPH, back-lighting brings out the interesting structure and texture of the ion exchange resin beads.



MIXED-BED UNITS in this Waterside Station of Consolidated Edison, New York, were designed and constructed by Illinois Water Treatment Company, Rockford, Illinois, a leading manufacturer of ion exchange equipment for many years.

for more than water conditioning, however. The desirability of exchanging one cation or anion for another was—and is—common to much of chemistry. Thus, as more varied Amberlite resins continued to be produced, as Rohm & Haas ion exchange specialists overcame the inadequacies inherent in the earlier non-resinous exchangers, the new technique developed into a unit process. Today, the chemist, engineer, biologist, physician, and other scientists think of ion exchange in terms of many uses in many fields. The list of Amberlite ion exchange resins, as well as the list of operations which they are called upon to perform, is long. Both are growing.

#### Multiple-Bed Deionization

As conventionally practiced, deionization, the removal of all ionic impurities from solution, involves the passage of the liquid undergoing treatment through separate beds of cation and anion exchange resins. Usually, the cation exchanger is employed first, the acidic effluent being passed into an anion exchanger to complete the deionization. Where low pH cannot be tolerated, reverse deionization is used: the initial bed used contains an anion rather than a cation exchanger. Since all ion exchange reactions are equilibrium phenomena, quantitative exchange cannot be effected by passage of an electrolyte solution through a single column of resin. Leakage which occurs can be minimized, however, by the use of a series of alternating cation and anion exchange columns. In such systems, the ionic strength of the solution is decreased in stages analogous to the "theoretical plates" of distillation theory. The final effluent, therefore, is of much higher quality than that obtainable from two-bed systems.

EIGHTY-SIX

When four-bed systems are employed, for example, water having an electrical resistance of greater than 200,000 ohms may be obtained.

#### Monobed Deionization

In the Monobed system of deionization, the solution to be treated is passed through an intimate mixture of Amberlite cation and anion exchange resins. Such a Monobed or "mixed-bed" may be regarded as a multiple-bed deionization unit consisting of countless numbers of cation and anion exchange columns arranged alternately in a series. Since hydrogen ions produced during the cation exchange cycle are almost immediately removed from the scene of action by adsorption or neutralization on the anion exchange resin, and since any hydroxyl ions produced on the anion exchange resin react with hydrogen from the cation exchange resin, even very unfavorable exchange equilibria may be driven to completion in a Monobed unit.

The Monobed technique, the most recent deionization process, is capable of yielding water of exceptional quality. By proper choice of resins, it is possible to prepare water chemically equivalent to "conductivity" water.

Because the Amberlite anion exchange resins are less dense than the cation exchangers, the resin mixture may be hydraulically separated into two discrete layers for regeneration. This is generally accomplished by backwashing the resin bed with a flow of water,



AN OPERATOR is backwashing the resin bed in this typical ion exchange resin installation.

which causes the resins to separate according to their respective densities. An internal regenerant system then permits regeneration and rinsing of the individual resins.

Among the advantages of the Monobed technique over other ion exchange methods are:

- 1) lower capital investment in equipment
- 2) lower rinse requirements
- 3) consistently high effluent quality
- 4) high capacity
- 5) greater degree of deionization

### Water Conditioning

Spurred by the introduction of synthetic ion exchange resins a little over a decade ago, the ion exchange method has not only earned widespread recognition in water conditioning, where it had its beginning, but has moved to other fields. Like distillation, evaporation, crystallization, or filtration, ion exchange is now accepted as an "unit operation"—one of the relatively few fundamental operations upon which various processes are built.

Nowhere has the adaptability of the Amberlite exchangers for specific tasks been so successfully illustrated as in conditioning of water—essential to industry and equally indispensable in the home. Every industry, in some way, requires water: as an ingredient in manufacturing or processing; as a solvent, cleaning medium, heat exchange agent, or catalyst. Indeed, so versatile and omnipresent is water that there is frequently a tendency to take it for granted, to forget that it is an industrial raw material of primary importance.

Unfortunately, the composition of raw water, as obtained from wells, rivers, lakes, or other sources, is extremely variable. All such water contains various chemical contaminants: dissolved or suspended materials drawn from the land which the water drains, poured into it from sewer outlets and factory drainage systems. Water in the Midwest differs from water of the Atlantic seaboard. Well water is different from river water, and river water from lake water. Two plants along the same body of water, perhaps separated by only a few miles, may have water supplies of very dissimilar characteristics. Even concentration and character of the dissolved materials may vary with changing seasons in the same locality.

For many industrial and domestic purposes, then, water must be treated to remove specific contaminants. Often it must be softened, sometimes dealkalized. In certain areas, sulfides and fluorides must be removed and, on occasion, complete deionization is necessary.

The Amberlite ion exchange processes — both cationic and anionic exchange — present almost ideal methods for overcoming the limitations of natural water supplies. In areas where water is abundant, these exchangers may function primarily to improve water quality. Where water is scarce, the Amberlite resins also permit its conservation by making possible the re-use of waste water.



HERE A TECHNICIAN is adjusting the flow rate in a laboratory type ion exchange column.

### Water Softening

Perhaps the most common and least tolerable chemical impurities in water are the hardness producing ions, calcium and magnesium, generally present as dissolved salts in combination with bicarbonate, carbonate, and sulfate anions. The soap which wastes its substance by refusing to lather well and the scum or curd which forms along the sides of the bath tub are homely examples of the inconvenience and added expense to which the user of hard water is subjected, whether in the home or industry. Hard water transforms ordinary soap into insoluble calcium and magnesia soap.

Because the sticky, insoluble magnesium and calcium soaps adhere to laundry, cleanliness as well as money is sacrificed. The scale which deposits and builds up in steam boilers, water piping, condenser jackets, circulating systems, cooking utensils, and other equipment contacted by hot water is an example of more than just inconvenience and modest additional expense. The cost of fuel, labor, and maintenance is considerably increased.

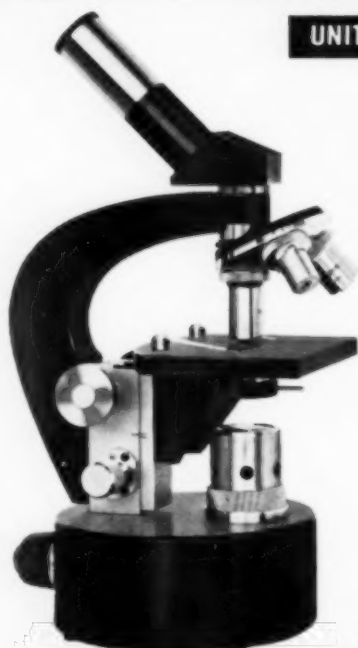
### Dealkalization by Anion Exchange

The introduction of strongly basic anion Amberlite exchange resins several years ago has led to the development of a radically new method for reducing alkalinity. One such Amberlite resin, for example, when regenerated with salt to produce the chloride form of the resin, will exchange its chloride anions for others such as bicarbonate, sulfate, fluoride, and sulfide.

While equilibrium conditions are not entirely favorable for the adsorption of bicarbonate ions, the ex-

*(Continued on Page 98)*

# UNITRON student microscopes offer



**UNITRON STUDENT AUTO-ILLUMINATION MICROSCOPE, MSA**

The UNITRON Student Auto-Illumination Microscope, Model MSA, employs a newly designed stand in which all components and controls are within easy reach. The inclined eyepiece tube allows comfortable posture and may be turned in any optional observing direction to permit two students sitting side by side to share a single instrument. With the built-in illuminating system of the superior low-voltage type, each student is assured of the correct lighting. The transformer is conveniently housed in the microscope base itself where it contributes to the stability of the stand rather than to the clutter of the laboratory table.

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## Are These The World's Oldest Lenses?

• By **Bernard W. Powell**

NATIONAL ASSOCIATION OF SCIENCE WRITERS

*In addition to their many missionary endeavors in North Africa, the White Fathers maintain our archeological museum. One of their exhibits contains a very interesting collection of lenses.*

*The very delicate work of many ancient craftsmen seems to indicate that they must have used magnifying glasses, yet we find very little mention of lenses in ancient writings.*

In 1609, as astronomers will readily agree, Galileo Galilei turned his famed "optic tube" towards the Italian skies, and so became one of the first observers credited with using glass lenses to apply the principles of magnification. Shortly after him came Antony Leeuwenhoek, the eccentric Dutch janitor, who captivated the Royal Society with his reports on "wretched beasties" glimpsed in a drop of water with his crude lenses and early microscopes. Yet, as a fact of interest

to those who follow optical history, it seems rather well established that proper glass lenses were being ground, polished and used by artisans in an ancient North African city 2000 years before the time of Galileo and Leeuwenhoek.

Not far outside the modern city of Tunis is a gently sloping hill in the North African plateau country. For centuries known as the Byrsa, this hill is the site of ancient Carthage—Rome's one great rival for mastery of the Mediterranean long ago. Atop this hill today stands the Lavigerie Museum maintained by the White Fathers of the Desert. Here are housed, in the keeping of Father R. P. Ferron, director of the museum, what are probably ten of the oldest lenses in the world.

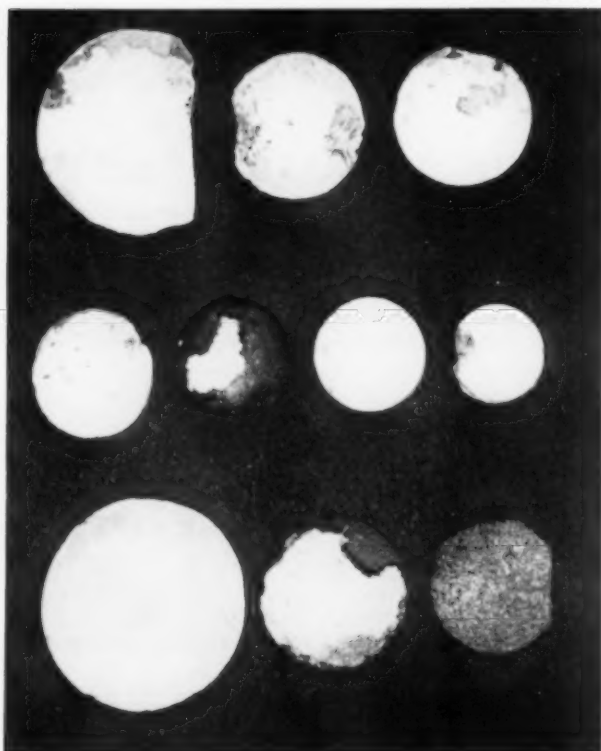
Early in the 1900's, the White Fathers excavated several Carthaginian graves in this region. In these graves, among other articles, were the lenses. The burials unquestionably date from the period between 300 and 400 B.C. It is fortunate, indeed, that the lenses were reclaimed at all. Students of history know full well the awful retribution Rome exacted on her Carthaginian enemies when Carthage finally fell in 146 B.C. The city was utterly destroyed. Walls were razed, the city sacked and burned, and plowmen plowed furrows into which salt was sown, so that crops would grow there nevermore! So complete was the destruction, that only human relics already interred deep in the ground and dating from much earlier times escaped the damage. The lenses thus were already lying deep in early Punic tombs while Rome and Carthage waged their bitter struggle to the end.

Eight of the lenses are glass. The glass is bubble-filled, true, but nonetheless is true glass, and indicates that the makers knew what they were setting out to obtain when they cast the blanks. The remaining two lenses are of polished rock crystal. All are roughly circular and have definite convex surfaces. In size, they range from the smallest, about 3/4" in diameter, to the largest, about 1-1/4" in diameter. The lapse of centuries and conditions prevailing in their subterranean resting place has given the lenses a mottled, pearly-white, opalescent patination. One of the smallest is also one of the clearest and still retains a fairly high polish. It has a magnification of about four diameters (4X).

No trace of a mounting of any kind was found with the lenses. Possibly they may have had wood or ivory holders but these are long since gone, if they ever existed. It was originally thought that perhaps the lenses were really spectacle lenses and were held close to the face in some manner to aid vision. The early Chinese, and Europeans in the 13th century, seem to have known of the use of spectacles, but it is now believed that

*(Continued on Page 99)*

*—Courtesy Lavigerie Museum, Tunis, and Bausch & Lomb Optical Co., Rochester, N. Y.*



TEN SIMPLE LENSES excavated from ancient Carthaginian graves in North Africa may well represent the oldest lenses in the world. They date from the period between 300 & 400 B.C.

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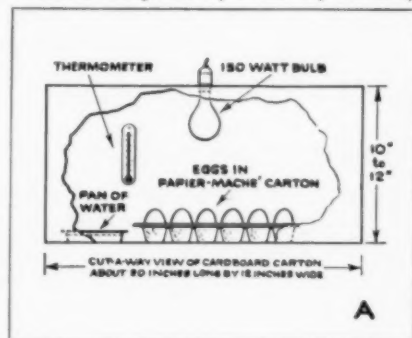
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## EXPERIMENT

**Studying the growth of a living chick embryo**

### MATERIALS AND PREPARATIONS

1. Supply of fertilized chicken eggs — preferably 24 hour chick embryos. These can be obtained inexpensively from any hatchery.

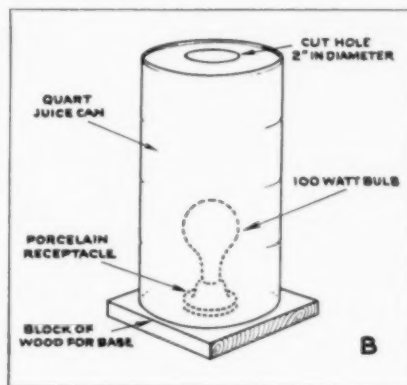


2. Incubator: (See diagram). Optimal temperatures are 90° - 110° F. Place small pan of water in incubator for proper humidity (about 60%).

3. Egg Candler: (See diagram B). To candle simply place egg over hole. (Candle in darkened room).

4. Set up Cycloptic Microscope. Melt paraffin and keep hot. Cut "nest" from papier

mache' egg carton. Have sharpened steel needle, tweezers, wide mouth medicine dropper, sharp manicure scissors, small brush and clean cover glass ready at hand.



### PROCEDURE

1. Select 2 - 4 day old egg. Candle egg to locate position of embryo. This will appear as a shadowy network of blood vessels (area vasculosa) radiating from an indistinct dark spot, which is the embryo.

2. Mark position of embryo on shell with grease pencil . . . do not rotate or roll egg since embryo may shift. Place egg in nest with embryo up.

3. Cut window about size of dime over embryo. Start by carefully picking with needle until small hole is made. Then insert point of manicure scissors into hole and cut (see photo C). Use tweezers to remove pieces of shell. Very carefully puncture egg membrane (immediately under shell) and remove with tweezers. Embryo should now be exposed on top of yolk. Remove excess albumen, if necessary, with medicine dropper.



4. Seal cover glass in following way: with camel hair brush apply melted paraffin to the edges of the window. Gently place cover glass over the window. Seal edges with paraffin. (See photo D).



5. Place egg under Cycloptic Microscope for study. (See photo E). Chick embryo will remain alive for many days and its nervous and circulatory systems can be observed and wing and leg buds can be detected in various stages of embryonic development. Keep egg incubated between observations. Use of sterile technique (wash instruments in 70% alcohol, rinse in sterile .9% saline solution) will keep the embryo alive for a longer period.



**OBJECTIVES:** This experiment, of course does not attempt to impart a fund of knowledge concerning embryology. However, it lends itself ideally to the achievement of many basic science teaching objectives; i. e., the principles of reproduction and heredity; instrumental and manipulatory skill; appreciations of the work of scientists and the scientific method. And finally, because this experiment has been actually used in classrooms, we know it creates an interest in the whole broad field of science.

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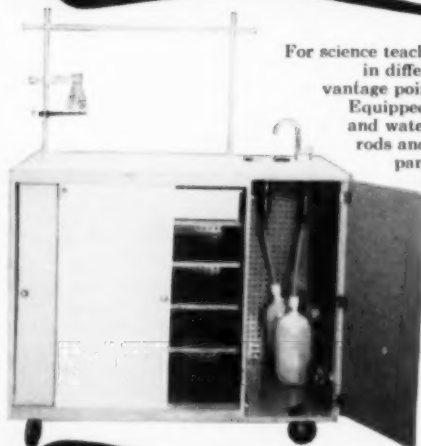
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## Projects Build Scientists

(Continued from Page 84)

ganizations eager to encourage youthful scientific interest!

Personal observation of what goes on in the world, trips, hobbies, experiences, and imagination accounted for about a fifth of the project ideas. One student even "dreamed it one night."

Another 17% said their ideas came from school or from teachers and science club sponsors.

For 23 of the finalists, this year's exhibit was a continuation of long-term work or the outgrowth of former science experiments. Discussions with or advice from scientists, university professors or doctors started 18 projects.

Another 13 stemmed from science fairs or science congresses, meetings or programs. Families and family discussions inspired ten successful exhibits, and four finalists found their project ideas in jobs they had held in scientific fields.

But who helps them? Surely they can not do all this advanced work alone and without some expert guidance? Of course not. Like all good scientists, these students attempt to find out what already has been done in their particular fields, and they do need professional evaluation of some of their ideas and methods. This is where adult scientists, parents, teachers and other people with "know how" enter the picture.

There is, in fact, a gigantic "Project Protege" (as one such local activity was called) going on all over the country. Without publicity, and even without very much notice or appreciation from the rest of us, hundreds of highly competent specialists in industry, universities and laboratories are nurturing many of the embryo scientists of the next generation.

Uncounted hours of advice, pieces of hard-to-get equipment, unpublished reports have been made available to young students by busy scientists who often defer their own work or leisure to start a youngster on his way. Immeasurable enthusiasm and dedication have been exchanged in the process, to the mutual benefit of everyone involved.

This kind of incalculably important help is going on everywhere, from the office of a physician in an isolated rural community to the laboratories of world famous scientists and the office of the President's Committee on Scientists and Engineers.

For example, this summer the President's Committee heard that National Science Fair finalist Joel Dressler, 15, of Arlington, Va., had wistfully complained that there was practically nobody he could talk to about his project on anti-matter. Understandably, most people begin to look dazed almost immediately and are able to think of very few appropriate comments or questions.

The Committee was able to make arrangements for Joel to visit the Atomic Energy Commission in Wash-

ington where he spent several hours talking to various experts, including Cmdr. Harry J. Watters who is entirely at home with the notion of an anti-universe. It turned out that Cmdr. Watters was the specialist who was gotten out of bed one night last spring to judge Joel's project at the Northern Virginia Science Fair, since no one on the Judging Committee felt qualified to score it.

Joel left the AEC with pamphlets and reports, and an invitation to come back often. Like many other teen-agers, he intends to use his summer leisure to good advantage in continuing his project. Now, of course, he will be able to ask for advice if he finds himself boxed in by too many frustrating problems.

The experience of Neil Nininger, 18, of Larkspur, Calif., under one of the University of California Radiation Laboratory's summer fellowships for promising high school students is an example of what the scientist-student relationship can produce.

A finalist at the National Science Fair in 1956, Neil met Dr. Glenn Seaborg when he appeared on a television program with the Nobelist that year. Dr. Seaborg was impressed by Neil's apparent ability and invited him to accept one of the fellowships at the Radiation Laboratory that summer. Neil carried out his assigned project so successfully that he was invited to return in 1957 and again this summer.

Another famous scientist, Dr. Edward Teller, "father of the H-bomb," chose Neil as one of five outstanding science students to take part in a series of television programs with him.

This year Neil entered the 17th Science Talent Search for the Westinghouse Science Scholarships and Awards, conducted by Science Clubs of America as an activity of Science Service. He won one of the top five scholarships and this fall will begin college training as a physical chemist of unusual promise. He was recently announced also as a winner of a National Metals Award in the competition conducted by the Future Scientists of America Foundation of the National Science Teachers Association.

It is scarcely necessary to comment that these are only two of many hundreds of equally promising pre-scientists, both boys and girls, who show every indication of developing their potential, given sufficient opportunity.

It is not difficult to understand, then, why adults who know about or work with these young people look toward the future with the most optimistic anticipation! •



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The 16 brilliant paintings were done by Walter Mesaros, a specialist in illustrating space subjects. Spectacular full-color paintings graphically give facts and figures about the many phases of space travel and its possibilities. In the center is a large picture showing our solar system in an unusual aspect as viewed looking south rather than the conventional view. All the planets are named and the orbit of each is shown by a color band. The other paintings are arranged around the center spread. They include these fascinating subjects: space suit, space taxi, how a rocket works, various types of satellites—TV, nuclear-powered and solar-powered, space ships, tracking camera, space station, even a picture of a possible moon settlement.

In addition there are scale drawings of the 9 planets with facts such as density, diameter, distance from the sun, etc. One interesting panel shows the effect of gravity and how high a man could jump on each planet.

Another fascinating panel shows the atmosphere and beyond and indicates how far man-made satellites have gone—the path of the Vanguard, the Explorer, and the Sputnik (the plural of which, incidentally, is Sputniki).

Each illustration is captioned and all the necessary parts are labeled. On the back of the chart is a detailed description of each painting. Together these descriptions tell the story of space travel and its problems. Difficult concepts such as inertia, centrifugal force and gravity are simply explained.

Walter Mesaros, the artist, obtained a photograph of the moon taken through the world's largest telescope at Mt. Palomar. This photograph taken when the moon was at 2nd quarter shows about  $\frac{1}{4}$ th of the moon's surface in a print 8 x 10 inches in size.

From the print, Mesaros selected an area about the size of a postage stamp which was out toward the curved edge where one side of the mountain would show. This area was enlarged to 11 x 14 inches which brought out clearly the moon's craters but does not show individual characteristics of various peaks.

In this enlargement, Mesaros selected an area of about 4 square inches and enlarged this to 11 x 17 inches. In this second enlargement, the individual characteristics of each mountain peak were shown, so Mesaros selected an area of about 12 square inches and rendered it in perspective as it would be seen from a position on the moon.

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## Impact of Mathematics

*(Continued from Page 80)*

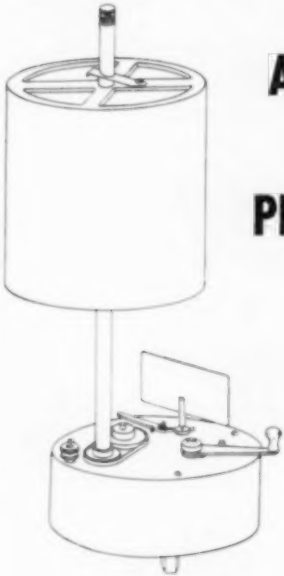
appear (not written by the Commission) to conform to these suggestions.

The University of Illinois has suggested a program inspired by Max Beberman, a teacher in the University High School at Illinois, and Herbert Vaughn, a member of the faculty of the University. The algebra books, which are available, are quite different from any other algebra texts, and also different from the Commission's recommendations, although in these also great emphasis is placed upon the set concept. In the Illinois program the word "variable" is avoided and "pronumeral" used instead, i.e., a "pronumeral" is a letter used for a number in the same way that a pronoun is used to represent a noun. The teaching of this course would require special teacher-preparation, and almost a complete reorganization of the thinking of the teacher.

A third program is under the direction of Professor E. G. Begle of Yale University and the group responsible is called the School Mathematics Study Committee. The purpose of this committee is to produce sample textbooks and teaching aids to serve as patterns for other groups. The group met at Yale during the summer of 1958.

Whether the Catholic high school teacher is going to inaugurate any of these new ideas in his classroom or not (and eventually he no doubt will), he must know what these programs are about. How is this teacher going to know this so-called new material in order to teach it? First, he must read. The College Entrance Examination Board pamphlets have already been mentioned. He should peruse with some interest the publications—frequently pamphlets also—of the National Council of Teachers of Mathematics.<sup>4</sup> He must by all means, even if he read nothing else, obtain a copy of the Yearbook of the National Council called *Insights into Modern Mathematics*.<sup>5</sup> He should have a copy for himself of *Principles of Mathematics*<sup>6</sup> and of *Finite Mathematics*.<sup>7</sup> He must learn about the operation of computers and about the binary system, so that when a student brings in a number looking like 1110100110, and says, "My father says this means 1958 and wants you to tell me why," the teacher will know why.

If the Catholic high school teacher is able to obtain a grant from the National Science Foundation to attend a summer institute, such as was held at Fordham University this summer or at the University of Notre Dame for the past several summers, he should certainly do so. Such institutes are for the purpose of instructing those who are already experienced teachers in these newer ideas. The Catholic high school teacher who does not know just what is going to be demanded of him in the way of modern mathematics (it really is not so modern, by the way; much of it has been known for two hundred years), has a great deal of company. For most of the high school teachers throughout the country, unless they have recently been graduated from college, all these concepts and their applications are



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equally new. That is why the "Insights" book was written—to satisfy an ever-increasing demand for knowledge on the part of teachers.

The Catholic high school teacher must attend meetings of mathematics teachers and of mathematicians, the state mathematics meetings sponsored by the local division of the National Council, the American Mathematical Association meetings (open to non-members); in short, any group discussion or lecture that it is possible for him to attend. He can always learn something.

The program of Advance Placement sponsored by the College Entrance Examination Board should also be familiar to every mathematics teacher whether his school takes part or not. Many Catholic high schools are already taking part. This is a plan by which colleges offer advanced credit and placement for college level work taken by the student while still in high school, if the student does creditably on a uniform test prepared by the Educational Testing Service. The high school teacher may find that such a program is not feasible in his school, may already have a too-heavy teaching load to attempt it, or may simply disapprove of it. However, he must be aware of the program and all that it implies. He cannot insulate himself from developments of the day and say, "If I can cover the syllabus (or textbook), that is enough for me." A teacher in a Catholic high school must give his pupils

the best possible education, and if the best is the newest, that is what he must learn.

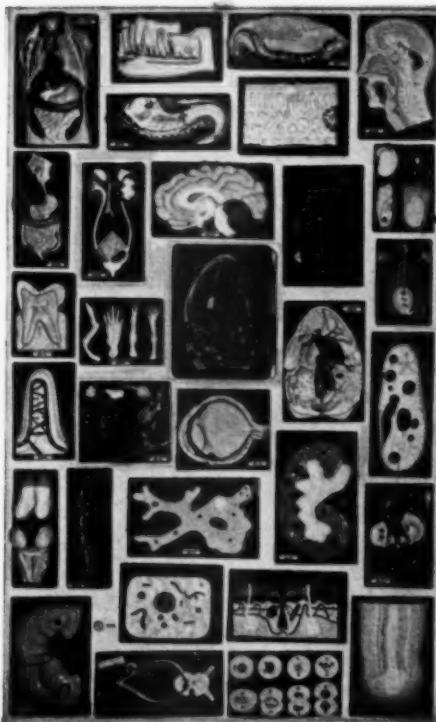
This is not to say that one should be carried away and immediately cry for a reorganization of the entire curriculum beginning this September. For one thing, except for the statistics book, there are no texts ready that fit the College Entrance Examination Board program if that program is chosen. But one should be ready to make changes gradually, know what possible changes might come about, know what is good in each program, and start right now, at the beginning of a new school year with new classes to teach the unity that exists among all the phases of mathematics. ●

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7. J. G. Kemeny, J. L. Snell, *Finite Mathematics*, Prentice-Hall, Englewood Cliffs, N. J., 1957.



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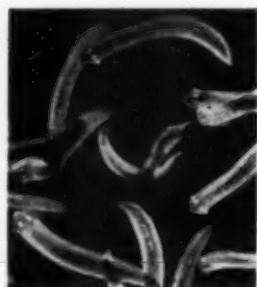
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**Ion Exchange Resins**

*(Continued from Page 87)*

change proceeds with sufficient efficiency so that, when viewed in the light of the following advantages, the process becomes highly attractive:

1. An inexpensive regenerant—salt—is used
2. No handling of hazardous acids is involved
3. No acid can be introduced to the boilers
4. No acid resistant equipment is required
5. No degasification equipment is required

**Dealkalization and Softening by  
Anion-Cation Exchange**

Since certain Amberlite resins in their sodium forms are used to soften water, and still another in the chloride form is used to dealkalize water, it is not startling to find that a combination of the cation and anion exchangers may be employed to provide completely softened, dealkalized water. It is unusual to find, however, that the resins need not be contained in separate units, although until recently separate units were most common. Equally good results are obtained if the resins, unmixed, are placed in a single column. The chemical reactions occurring in either system are identical. When the single column technique is used, the resins are automatically maintained in discrete layers, because of the relatively large density differential between them.

The advantages of employing a strongly acidic cation exchanger for water softening and a strongly basic anion exchanger for dealkalization are repeated in the combined softening-dealkalization process. Outstanding among these advantages, of course, is the use of a single chemical regenerant for both operations. Only brine is required.

**Deionization Including Silica Removal**

Few would deny that the chemical purification of water by distillation is an inefficient process at best, for in essence it consists not of removing the impurities from the water, but the water from the impurities. Since the quantity of water may exceed the quantity of impurities by as much as 10,000,000 to 1, the energy required for purification by distillation is large. The operation, therefore, is relatively expensive. For these reasons, the use of distilled water in the past was confined to those industries which did not require much of it. And for those industries where distilled water was merely desirable, it became a luxury in which they did not indulge.

In recent years, however, not only has the role of water purity in product quality been recognized and appreciated, but many industries have arisen whose existence, in some way, actually depends upon an adequate supply of chemically pure water. Fortunately, distillation is no longer the only purification technique available. Ion exchange resins now provide water of almost any desired degree of chemical purity in an

efficient and inexpensive manner by removing the small from the large—the dissolved impurities from the water solution. Where necessary, they are able to perform their job so thoroughly that water can be obtained whose quality is as good as or better than that resulting from the most exacting laboratory distillations.

Because deionization by ion exchange is capable of removing all ions from solution, it is a convenient way to obtain the silica-free water required for many modern boilers operating at high and moderately high pressures. Heretofore, silica, which not only tends to form scale in heating tubes, causing their early failure, but depositions on turbine blades as well, could be removed only by elaborate chemical treatment.

#### Applications of Ion Exchange

Today, in addition to its major use in water conditioning, ion exchange serves in the production of pharmaceuticals; combats the disastrous effects of peptic ulcers and cardiac edema; aids in the concentration and recovery of metals; acts catalytically in the preparation of organic chemicals; deionizes sugar sirups; and makes possible the analysis, isolation, and separation of compounds or elements heretofore con-

sidered too elusive for application of conventional techniques. In all of these applications, ion exchange operates with a dexterity and efficiency scarcely approached by older methods. ●

★ ★ ★ ★ ★

## The World's Oldest Lenses?

(Continued from Page 90)

these ten lenses represent simple lenses used by artisans for engraving gems and other tedious, exacting types of handwork.

The Carthaginians probably did not make the lenses. Father Ferron believes that they were imports from Phoenicia in the East. The Phoenicians were famous throughout the antique world for their glass. Some credit them with its discovery, and certain it is that glass was one of their earliest exports. If they were thus so familiar with it, it does not seem surprising that optics should have been one of their attainments, too.

Just how far back in history the use of simple lenses for magnification really extends has never been established. These ten lenses may well be the oldest lenses in the world. ●

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# New Books

## Science In Everyday Life

• By OBOURN, HEISS AND MONTGOMERY. D. Van Nostrand Company, Inc. New York. 1958. Junior High Text, 2nd Edition. \$4.68.

*Science in Everyday Life* is an interesting, contemporary text for use in a General Science course. In compact form it offers the teacher and student a full analysis of the natural sciences and their effect on life. Although the author realizes his limitations as to complete explanation of each science in a text of this sort, he overcomes this obstacle by discussing the main implications and properties of each. In this way the student should achieve a basic concept of each of the natural sciences and possibly be stimulated to investigate more completely one or two specific divisions.

The material is grouped into nine main units with each unit comprising three or four chapters as sub-units. Each chapter is then subdivided into several problems. This type of division is unique in that each problem could be considered as a single lesson or at most several days work for some of the larger problem discussions. The main units are complete in themselves and thereby offer flexibility to the course. The instructor is not limited to any rigid order of presentation, but can introduce any of the units as conditions or availability of training aids warrant its presentation.

The core or central thought of the text is energy and the author uses this approach to unify and intro-

duce each section. With this unifying element, the student should have little difficulty proceeding from one main section to the other. This absence of a sharp break-off in material also tends to enhance the flexibility of unit planning for the instructor.

The material is discussed in simple descriptive language and there are an abundance of illustrations and graphic explanations to simplify the more difficult sections. Throughout each section there are experience exercises to strengthen the lesson concepts by practical application. Here the student can gain procedure techniques in lab work although no actual class lab is set up for courses of this type.

Following each problem section are groups of questions to test the comprehension of the students. These can be used either as an outline for summation by the teacher or as an actual oral or written test. After each chapter is a similar arrangement with a short summary of each problem and discussion topics for student themes as means of integrating subject materials with student environment. At the end of each unit suggestions are made for student projects, discussions and field trips. Here also sources for more extensive investigations of the subject can be found. These projects and topics for discussion are of varying degrees of difficulty to allow for the diversified interests and abilities of the students.

Through this mode of presentation, the author strives to make the text as interesting and absorbing as possible without lessening the importance or coverage of the material.

Robert F. Gillespie  
Duquesne University

## Learning To Teach

• By MARY W. MULDOON. Harper and Brothers. New York. 1958. 287 Pp. \$3.50.

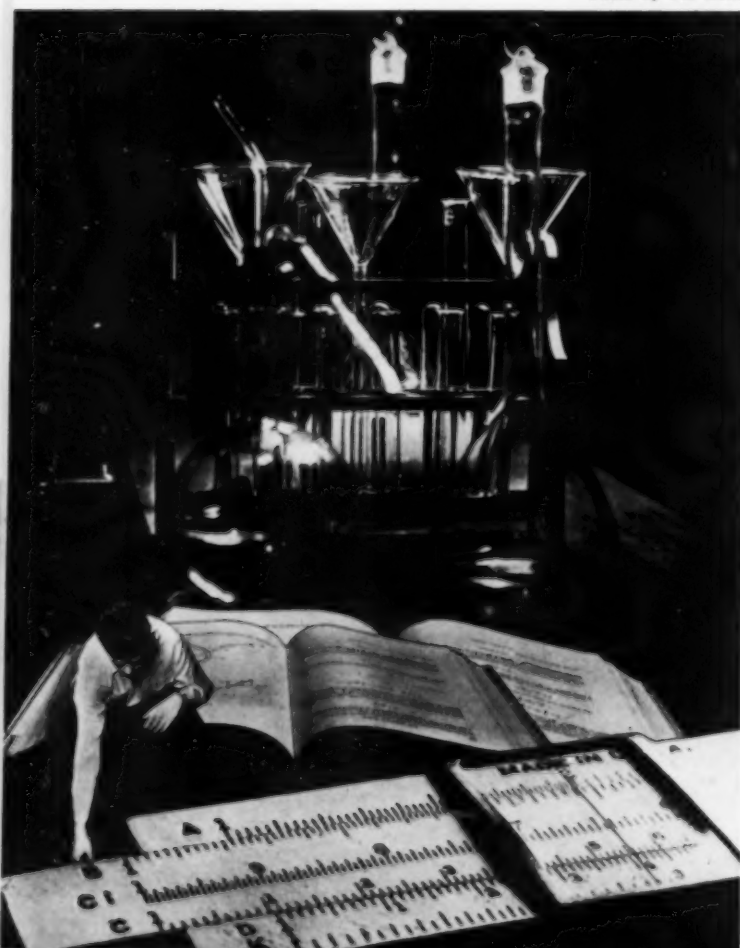
Although the subtitle of *Learning to Teach* is "A Handbook for Beginners," even a seasoned teacher will read it with profit and delight, recognizing that the author has caught and recorded the thousand and one methods and devices that usually have to be worked out through years of trial and error. The beginner who learns to teach through studying this volume is saved many a bitter failure.

Miss Muldoon is unquestionably an expert. She knows that often a young teacher, although his head is crammed with facts from required courses in pedagogy, will stand before his first class bewildered; at last solely responsible for thirty-five or forty active, restless, mischievous youngsters. This is his baptism of fire. Well he knows that attitudes established the first day will be reflected every day until the semester ends. He knows that students must recognize and respect his authority, that they must learn to be attentive, that their interest must be stimulated. He knows very well *what* he is to do; but he simply does not know *how* to do it.

The object of the book is to cover for beginners "situations and conditions which do not conform to the theory they learned, or which are not covered by it." The author's long experience as teacher, principal, and teacher-of-teachers has given her a first-hand knowledge of "the spots at which the beginners have most frequently run into trouble."

Because she is practical, she begins with the first day, explaining how to establish classroom routines, to take the roll, to fill every minute of the hour with profitable activities. Having created the proper conditions for receptivity, the teacher is shown how to prepare and present material worth receiving. Several chapters are devoted to planning lessons, arousing and sustaining pupil interest, testing. "Your task," says the

Photo by Vic Kelley



author, "is not to select only interesting things for teaching, but to make as interesting as possible the things that must be taught." A whole chapter is devoted to the constructive use of that pitfall of the disciplinarian—"spare minutes." Throughout the entire discussion of skills, Miss Muldoon uses concrete examples—sample tests, transcribed recitations, examples of difficult situations which arise in English, mathematics, social studies, science. In the Preface the reader is assured that "Every plan or suggestion listed has been used successfully from a dozen to hundreds of times."

Above and beyond the value of this volume in the teaching of skills is the wise counsel offered the young teacher on personal and professional relations, in-service growth, and even management of finances. Most important of all are the things Miss Muldoon has to say about the teacher's obligations to his pupils. She warns against that most despicable of all forms of gossip, gossip about the personality or affairs of a child. A confidence betrayed permanently destroys the teacher's usefulness to that child and to every child who knows him. A teacher must be cooperative, honest, sincere—a fine person. "To many a child his teacher is the finest person he has ever known. For some of these children, the teacher is the finest person they will ever know. You carry, therefore, a tremendous moral responsibility . . ."

The style is refreshingly crisp and clear, entirely free of pedagogical jargon. The arrangement of material is ideal either for use as a text book or for private study. Chapters are divided into sub-divisions: each is followed by a terse summary and a list of challenging questions on problems allied to the matters discussed.

For twenty-two years Mary Warren Muldoon has been principal of the school which now bears her name, the Mary W. Muldoon Junior High School. She was a classroom teacher of marked ability before she became Principal. She has a long record of activity in professional organizations. She originated the drive for the Welfare Fund of the New York Teacher's Association which she now assists in administering and which is called "The Mary Muldoon Fund." For twenty summers she taught at Oswego Teachers College and for three in the State Center for Industrial Teacher training in New York City. She has addressed conventions hundreds of times and written many newspaper and magazine articles. Miss Muldoon is the sister of the late Dean Hugh Muldoon who founded the School of Pharmacy at Duquesne University.

The material in *Learning to Teach* is the distillation of notes from two decades of faculty meetings, twenty summers as an instructor in teacher training institutions, and all her experience in helping hundreds of young teachers just entering upon their careers. In fact, between the covers of one slim volume, the author condenses for the reader a lifetime of practical "know-how."

Loretta P. Byrne  
Dean of Women  
Duquesne University

## Electricity And Magnetism

- By MYRON J. ATKIN AND R. WILL BURNETT. Rinehart and Company, Inc. New York. 1958. Pp. 58. \$1.00

The authors present the contents in three parts:

1. How to Use This Booklet;
2. An Overview of Electricity and Magnetism for the Teacher;
3. Demonstrations, Experiments, and Other Activities.

The scope and sequence chart of concepts on electricity and magnetism are very helpful in planning science experiences beginning with the kindergarten level through grade six. It is an excellent guide of suggestions for tested activities which will give the pupils a deeper understanding of the basic aims and methods of science in a modern world. References for the teacher and for the children are listed for additional research.

The theory of each topic is readily available for the inexperienced teacher who might otherwise waste much time and effort searching for answers. The diagrams are very clearly sketched and the materials are inexpensive and easily handled. The instructions are very specific and precise, e.g., thirty or forty strokes are usually necessary to magnetize a piece of iron or steel with a fairly strong permanent magnet. Static electricity experiments work best on cold, dry days. When the moisture content of the air is high, the air becomes a relatively good conductor of electricity, and static charges built up on various objects easily leak off.

Elementary teachers, general science teachers, and scout leaders will find this a most valuable pamphlet to challenge the "average" and "gifted" pupil as supplementary practice.

Sister M. Aelred, OSF  
St. Joseph High School  
434 Ormsby Avenue  
Pittsburgh 10, Pa.

## Air, Winds, And Weather

- By C. MYRON ATKINS AND R. WILL BURNETT. Elementary School Science Activities Series. Rinehart and Co., Inc., N. Y.

This 58-page pamphlet is one of a series in Elementary Science designed to provide many class-tested demonstrations that teachers have found effective. The experiments have been selected for their ease of execution and the simplicity of the materials required. Simple black and white drawings by Raymond Perlman clarify the text.

Francis Kleyle  
Chairman, Dept. of Elem. Ed.  
School of Education  
Duquesne University

## Behind The Sputniks

- By F. J. KRIEGER. The Rand Corporation. Public Affairs Press. Washington, D. C. 1958. Pp. vi + 380. \$6.00.

The reader who is seeking an accurate picture of the development of Soviet space science and rocketry will find this work to be an excellent source of authoritative information. Its author, F. J. Drieger, is a leading authority on the subject, and this particular study was part of a research program undertaken for the United States Air Force by the RAND Corporation.

The body of the book is made up mainly of translations of Russian language articles from 1950 to October 1957. Most of the articles are popular in style, but they give an accurate picture of present day Soviet science. An excellent introduction summarizes the development of Russian space science from the turn of the century until the present. The appendices contain information on the establishment of the Soviet Gold Medal in the field of interplanetary communications. The Commission of Interplanetary Communications, and several items which give indirect evidence of the importance of astronautics in the U.S.S.R. Finally there is a bibliography of over three hundred entries.

J. P. M.

(Continued on Page 103)

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## An Ancient Metal---Lead

(Continued from Page 83)

of 1957. Other important tonnage-wise consumers include: paints, solder, calking lead, and ammunition.

Recent technological developments have opened new fields for the application of lead. Just what effect any one or all new uses may have on industry is difficult to foretell. But the most recent literature and brochures on the lead industry optimistically point to a steady increase in lead consumption. By virtue of its high density lead serves as an efficient protective shielding against X-rays and gamma rays. As a result more and more lead is required in our atomic age for the construction of lead lined hospital X-ray rooms, as well as the fabrication of lead shields for nuclear reactors<sup>17</sup> and various other gamma shields for educational and industrial research. Some other new uses, perhaps not as glamorous, but which may cause the lead industry to operate at a higher rate of capacity include: flexible lead plumbing connections, antimonial sheet lead for roofing and flashing, leaded porcelain enameled products such as steel and aluminum, leaded glass labels and enamels, lead stabilizers in vinyl plastics, and rechargeable dry cell batteries to power electronic circuits.<sup>18</sup>

Lead's importance to our modern way of life should not be underestimated. Its use in industry has and will continue to contribute much to our standard of living, and consequently our economic well-being. In order to find new uses and expand present applications the lead industry recently completed a survey of lead's research possibilities.<sup>19</sup> The results of this examination were so favorable that industry has embarked this year upon one of the largest research and market development programs within the history of lead.<sup>20</sup> This, of course, indicates that scientists do not look upon lead as an ancient "dead" mineral that has outlived its usefulness; but rather, consider it a metal of the future. ●

### NOTES

1. Carlson, A. S., *Economic Geography of Industrial Materials* (New York, 1956) pp. 259-62.
2. Lead Industries Association, *Lead in Modern Industry* (New York, 1952) p. 2.
3. Clark, J. G. D., *Prehistoric Europe* (New York, 1952) p. 196.
4. Because of lead's toxicity, its use in the modern cosmetic industry is limited. For a good concise treatment of ancient paints, pigments and cosmetics see Forbes, R. J., *Studies in Ancient Technology* (Leiden, 1955) Vol. 3.
5. Pliny, *Natural History* 34.50, 167.
6. Normally, only soft waters high in CO<sub>2</sub> and oxygen content require that protective measures be taken before installing lead pipe for domestic purposes. For the desirability of lead services in domestic water systems see Ziefeld, R. L., "Conditions Covering The Installation of Lead Service Pipe," reprint from *Journal of the New England Water Works Association* Vol. LIV, No. 1, pp. 1-15.
7. Vitruvius, *De Architectura* VIII 6, 10-11.
8. Forbes, R. J., *op. cit.*, Vol. 1, p. 150.
9. Vitruvius, *op. cit.*, VIII, 6, 4.
10. Fabricated pipes also had to meet certain weight specifications. For example, a 40 inch pressure pipe had to weigh 480 pounds, a 20 inch pipe, 240 pounds, a 10 inch pipe, 120 pounds and similarly, other pipes in like proportions. Vitruvius, *op. cit.*, VIII, 6, 4.
11. According to Pliny lead-tin alloys for soldering lead pipe normally contained two parts of lead and one of tin. Pliny, *op. cit.*, 34.48, 160.
12. Frontinus, *De Aquae Ductu* I. 37.
13. *Ibid.*, I. 38ff. Ajutages may be classified as the first series of industrial parts to be standardized.
14. *Ibid.*, II. 112.

15. FAVIA GLYCERA FEC. inscribed on a lead pipe found at Rome. Favia was probably the proud owner of a small plumber's shop. Although the inscription states that Favia made the pipe, it is more than likely the product of one of her hired slaves. For this inscription see Egbert, J. C., *Study of Latin Inscriptions* (New York, 1923) p. 330.
16. Ziefeld, R. L. "Lead," *Engineering and Mining Journal* Feb. 1958, p. 134.
17. Mobile Nuclear reactors are presently being mass produced for educational and industrial use by Aerojet-General Nucleonics of San Ramon, Calif. Each 11 ton reactor utilizes 7,500 pounds of lead for shielding. *Lead* Vol. 21, Number 1, 1957, p. 2.
18. For the most recent applications of lead and its compounds consult the latest editions of *Lead*, a magazine published by Lead Industries Association, 60 East 42nd Street, New York 17.
19. Ziefeld, R. L., *op. cit.*, p. 135.
20. *Ibid.*

★ ★ ★ ★ ★

## New Books

(Continued from Page 101)

### Practical Astronomy

- By W. SCHROEDER. The Philosophical Library, Inc. New York. 1957. Pp. 206. \$6.00.

This is an excellent introduction to the study of the movements of the planets and stars. The author's effective use of charts and graphs enables the reader, whose knowledge of mathematics is limited to algebra and geometry, to calculate the time of eclipses, the

position of a planet on a given day, the position of a ship at sea and many similar problems. In spite of the fact that the reader is solving problems in calculus, no knowledge of the calculus is required. This book will be of great service to the beginning amateur astronomer.

In addition to his excellent presentation of the basic facts and laws of astronomy, the author describes the construction and use of various astronomical instruments such as, the nocturnal, the sundial, the quadrant and telescope. The reader, with only average manual skill, can follow his directions and construct a useful instrument.

We recommend this book to all who desire to do a little astronomical study on their own.

J. P. M.

### More Marvels Of Industrial Science

- By CAPTAIN BURR W. LEYSON. E. P. Dutton and Company, Inc. New York. 1958. Pp. 190. \$3.50.

This is an excellent book for the high school library or science reading shelf. It will give the young reader an undistorted picture of the work of scientists and introduce him to some of the most recent developments of modern industrial science.

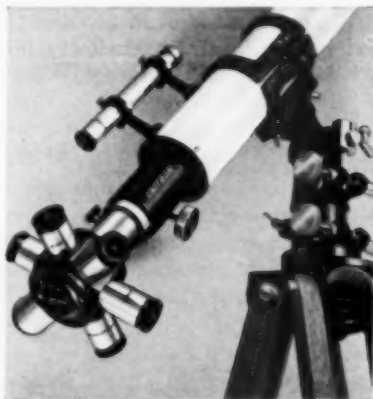
In each of the first eleven chapters an interesting discovery and its applications are discussed. The twelfth and final chapter briefly speculates on some of the

## THE SKY IS THE LIMIT

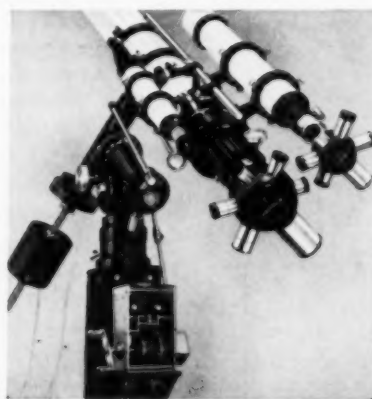
The fiction of Jules Verne is rapidly becoming fact as the world begins to adapt to a new "space age." Satellites are now in orbit. Sending a rocket to the moon is under active discussion. Outer space travel is sufficiently close for the conducting of military experiments to simulate its conditions.

In teaching, there is a compelling need to give students an opportunity to do more than just read about the universe. Apply visual education, let them see for themselves our neighbors in the solar system and outer space.

An astronomical telescope must be capable of resolving pinpoints of light at enormous distances. It, therefore, has to be designed specifically with that objective in view. Highly precise and matched optics are essential to obtain the crystal-clear image definition so necessary for astronomical observations to be meaningful. Mechanical mountings must also be built to close tolerances in order to accurately track a star or a planet. You will find all of these requirements superbly matched in a UNITRON.



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future marvels for the home and industry. The topics chosen are from many branches of science, weather modification, artificial lighting, solar energy, nuclear power, rocket engines and several other interesting topics are interestingly presented.

The chapter on weather modification gives perhaps the best example of the way in which discoveries in diverse fields find common application in an apparently unrelated field. The author points out how principles uncovered in the development of gas masks, static electricity, de-icing of airplane wings, chemical smokes, and the dispersion of ground fog, lead to successful experiments in the modification of weather. From the viewpoint of a teacher this chapter is the most valuable in the book, although the young reader might find another chapter such as the one on rocket motors more interesting.

J. P. M.

### Countdown For Tomorrow

• By MARTIN CAIDIN. E. P. Dutton and Company, Inc. New York. 1958. Pp. 288. \$4.95.

The subtitle of this book, "The Inside Story of Earth Satellites, Rockets and Missiles and the Race between American and Soviet Science," adequately describes its content.

The author discusses the launching of the Russian SPUTNIK, its diplomatic and political implications, the reasons for Russia's success and the defects in the United States' program. In his criticisms of the United States' efforts he is somewhat sharp but not unfair.

Those who are interested in the political, diplomatic

or scientific aspects of our space and missile programs will find this book most informative.

J. P. M.

### Our Nuclear Adventure

• By D. G. ARNOTT. The Philosophical Library, Inc. New York. 1958. Pp. xi + 170. \$6.00.

The destructive potential of nuclear energy and its possible constructive applications make it imperative for every citizen to understand the fundamental facts of nuclear science. The author states in the prologue that these facts can be made intelligible to the layman, and *Our Nuclear Adventure* proves him to be right.

While there are other books that are equally as good in the field, this book is especially interesting in that it is written by an Englishman and the British view on many of the controversial problems is interestingly presented. In addition most of the sources used are British.

J. P. M.

★ ★ ★ ★ ★

## Borax — Super Fuel

From kitchen drudge to the glamour of space conquest. This is the Cinderella-like story of borax.

Today, a superfuel derived from this mineral is the hottest development in military flying since the dawn of the jet age. Based on a combination of boron (from borax), hydrogen and various hydrocarbons, this "zip" fuel can increase the speed and range of a jet by 50 per cent. Higher operational ceilings for aircraft are possible, too. Flame-out, the fear of jet pilots flying in the thin air of high altitudes, has been eliminated. But these increases may at best promise only a holding action for manned aircraft against unmanned missiles.

It is the first of the superfuels to come from science's search for more powerful energy sources to drive tomorrow's supersonic aircraft, missiles, even space ships.

Boron, however, is no Johnny-come-lately. It was first isolated in 1808. A non-metallic element, it is a soft brown powder that ignites in air. A curiosity for many years, it proved attractive to fuel researchers for two reasons. It is the fifth lightest element and combines well with hydrogen which produces more energy per pound burned than any other substance.

The new boron-based superfuel is a transparent liquid ranging in tint from blue to amber. Its odor is less pungent than that of gasoline, and it fills the need for safe handling plus high energy content. At the present time, this zip fuel is considered suitable for aircraft only.

Besides military use, boron and boron compounds hold commercial promise as production costs are lowered. Glass fibers, heat-resistant metal alloys, atomic radiation shieldings—these are a few of the new uses. Yet high energy fuel, in the long run, is the most important.

Boron's fuel applications are now primarily military. But one day they may well help bring the ultimate realization to man's age-old dream of flight—a journey into interstellar space.

—CHEMICAL NEWS

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# You Can Depend on the GENATRON

## ● THE MODERN ELECTROSTATIC GENERATOR

THE CAMBOSCO GENATRON serves not only for classical experiments in static electricity, but also for new and dramatic demonstrations that are not performable by any other means. It exemplifies a modern method of building up the tremendously high voltages required for atomic fission, for nuclear research, and for radiation therapy.

Entirely self-exciting, the GENATRON cracks into action at the snap of the switch—whose only function is that of starting the motor drive. No auxiliary charging method is employed. Hence, despite an output measured in hundreds of thousands of volts, no hazard is involved, for the operator or for the observers.

*An Output of 250,000 Volts — or More!*

THE CAMBOSCO GENATRON is designed to deliver, in normal operation, a discharge of the order of 250,000 volts. That figure, a conservative rating, is based on many trials conducted under average conditions. With ideal conditions, a potential difference of 400,000 volts has been achieved.

**Modern Design**—Sturdy construction and ever-dependable performance distinguish the GENATRON from all electrostatic devices hitherto available for demonstration work in Physics. This powerful, high-potential source, reflecting the benefits of extensive experience in electrostatic engineering, has absolutely nothing but purpose in common with the old fashioned static machine.

**NO FRAGILE PARTS**—Durability was a prime consideration in the design of the GENATRON which, with the exception of insulating members, is constructed entirely of metal.

The only part subject to deterioration is the charge-carrying belt, which is readily replaceable.

**NO TRANSFER BODIES**—In all conventional influence machines, whether of Holtz or Wimshurst type, electrical charges are collected and conveyed (from rotating plates to electrodes) by a system of "transfer bodies." Such bodies have always taken the form of metal brushes, rods, button disk or segments—each of which, inevitably, permits leakage of the very charge it is intended to carry, and thereby sharply limits the maximum output voltage.

It is a distinguishing difference of the GENATRON that electrical charges, conveyed by a non-metallic material, are established directly upon the discharge terminal. The attainable voltage accordingly depends only upon the geometry of that terminal and the dielectric strength of the medium by which it is surrounded.

### Unique Features of the Cambosco Genatron

**DISCHARGE TERMINAL** Charges accumulate on, and discharge takes place from, the outer surface of a polished metal "sphere"—or, more accurately, an oblate spheroid.

The upper hemisphere is flattened at the pole to afford a horizontal support for such static accessories as must be insulated from ground. A built-in jack, at the center of that horizontal area, accepts a standard banana plug. Connections may thus be made to accessories located at a distance from the GENATRON.

**CHARGE-CARRYING BELT** To the terminal, charges are conveyed by an endless band of pure, live latex—a Cambosco development which has none of the shortcomings inherent in a belt with an overlap joint.

**DISCHARGE BALL** High voltage demonstrations often require a "spark gap" whose width can be varied without immobilizing either of the operator's hands.

That problem is ingeniously solved in the GENATRON, by mounting the discharge ball on a flexible shaft, which maintains any shape into which it is bent. Thus the discharge ball may be positioned at any desired distance (over a sixteen-inch range) from the discharge terminal.

**BASE...AND DRIVING MECHANISM** Stability is assured by the massive, cast metal base—where deep sockets are provided for the flexible shaft which carries the discharge ball, and for the lucite cylinder which supports, and insulates, the discharge terminal.

The flat, top surface of the base, (electrically speaking), represents the ground plane. Actual connection to ground is made through a conveniently located Jack-in-Head Binding Post. The base of the Genatron encloses, and electrically shields, the entire driving mechanism.

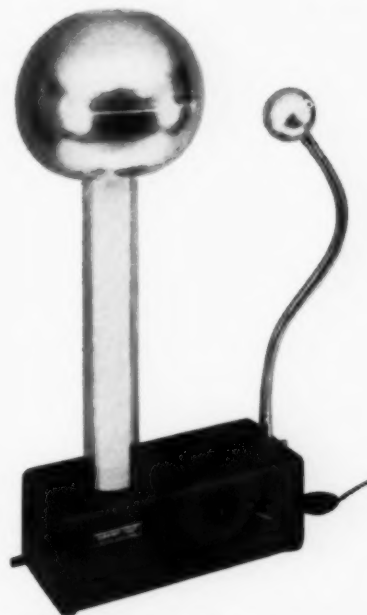
**PRINCIPAL DIMENSIONS** The overall height of the GENATRON is 31 in. Diameters of Discharge Ball and Terminal are, respectively, 3 in. and 10 in. The base measures 5¼ x 7 x 14 in.



**GENATRON, With Motor Drive**

Operates on 110-volt A.C. or 110-volt D.C. Includes: Discharge Terminal, Lucite Insulating Cylinder, Latex Charge-Carrying Belt, Discharge Ball with Flexible Shaft, Accessory and Ground Jacks, Cast Metal Base with built-in Motor Drive, Connecting Cord, Plug, Switch, and Operating Instructions.

**No. 61-705 - - - \$98.75**



**GENATRON, With Speed Control**

Includes (in addition to equipment itemized above under No. 61-705) a built-in Rheostat, to facilitate demonstrations requiring less than the maximum output.

**No. 61-708 - - - \$109.00**

**No. 61-710 Endless Belt.** Of pure latex. For replacement in No. 61-705 or No. 61-708. \$3.00

**CAMBOSCO SCIENTIFIC COMPANY**

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